MARINE TECHNOLOGY REPORTER

January/February 2019

www.marinetechnologynews.com

Vehicles Edition
AUVs • ROVs • ASVs

Unmanned Vehicles
25 Years of Evolution

Future AUVs
All About Disruption

GEBCO Seabed 2030
Heart of Oi '19 San Diego

Volume 62 Number 1

DURABLE

CONFIDENCE UNDERWATER

Portable underwater systems delivered with exceptional service, support, and reliability.

212 East High Street, Pottstown, PA USA 19464
sales@videoray.com
+1 610 458 3000

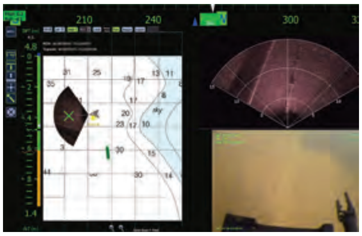
videoray.com

OPEN ARCHITECTURE

SOFTWARE CONNECTING THE MARINE INDUSTRY

NAVIGATION | AUTONOMY | UI | INTEGRATION

The **OPENSEA®** operating platform provides a fully-distributed, open architecture software framework for highly integrated systems across all brands of sensors, devices, and equipment while cutting-edge technologies for navigation and autonomy elevate system intelligence. One cohesive interface, Workspace, fuses system data into a comprehensive command center for streamlined workflow and improved productivity. Greensea's products are easily customizable and fully supported by knowledgeable, field-experienced engineers.



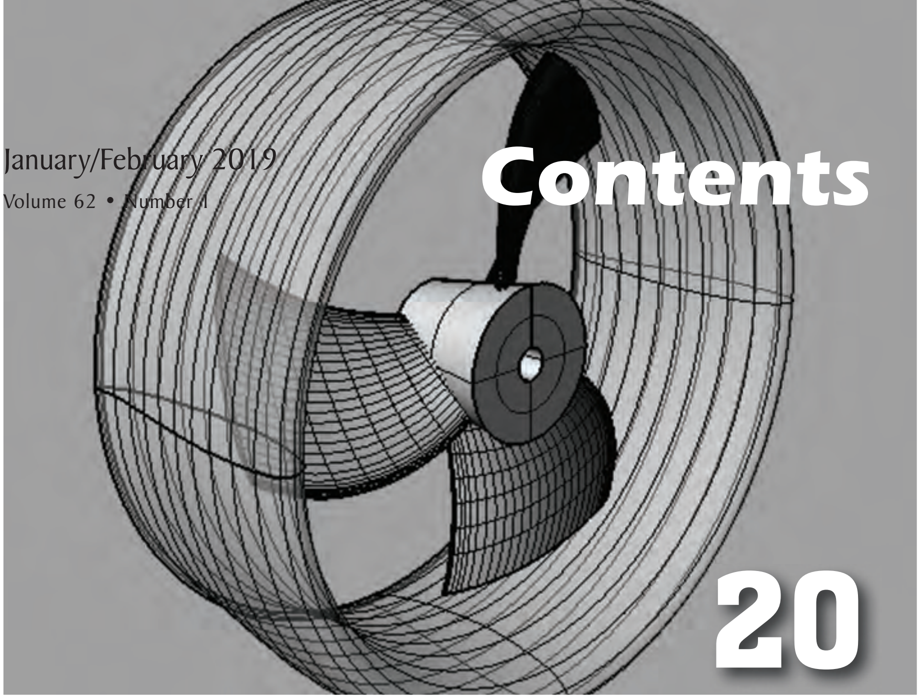
Visit Greensea.com or call **802.434.6080**
to learn more about application-specific configurations

- EOD & Special Forces
- Commercial OEM
- Oil & Gas

GREENSEA

January/February 2019
Volume 62 • Number 1

Contents



Hydrocomp

Greensea

Kongsberg

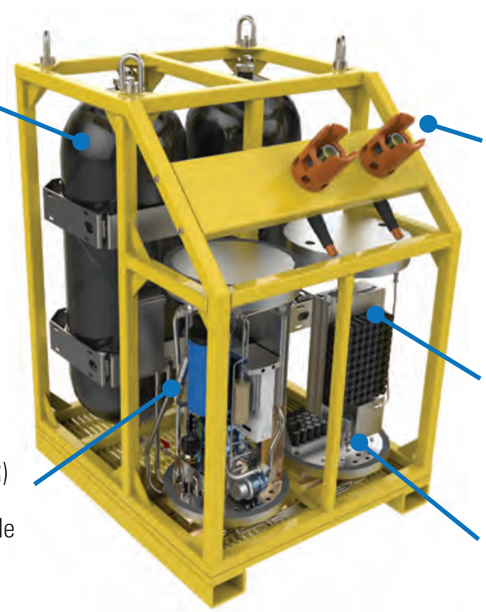
TELEDYNE ENERGY SYSTEMS
Everywhereyoulook™

+1.410.771.8600
www.teledynees.com

UNTETHERED SUBSEA POWER

INNOVATIVE SOLUTIONS POWERING PROGRESS ON THE SEA FLOOR

SUBSEA POWER NODE / POWER & UUV RECHARGING		
POWER	**ENERGY**	**SKID DIMENSIONS**
8kW, Continuous	100 Kwh	1.2 x 1.2 x 1.5 m



Watch more at **vimeo.com/249853952**

Subsea Energy Node Specifications

- Teledyne ejector driven reactant (EDR) fuel cell system
- Power: 16kW (continuous)
- Voltage output: 400 to 600 Vdc (regulated)
- Grid balancing capable
- Energy storage: 600 kWh
- Mass target: 3,370 kg
- Buoyant negative fueled, buoyant positive empty
- Skid: 3.7m x 1.5m x 1.2m
- Operating depth: 3000m

TELEDYNE ENERGY SYSTEMS
Everywhereyoulook™

www.teledynees.com

10707 Gilroy Road
Hunt Valley, MD 21031-1311
U.S.A.
P: +1.410.771.8600
F: +1.410.771.8618

Dr. Thomas Valdez
Manager
Chemical Systems
P: +1.410.891.2372
thomas.i.valdez@teledyne.com

Photo Credit: Jeff Milisen

www.marinetechnologynews.com

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

FLORIDA
215 NW 3rd St., Boynton Beach, FL 33435
Tel: (561) 732-4368; Fax: (561) 732-6984

PUBLISHER
John C. O'Malley
jomalley@marinelink.com

Associate Publisher & Editor
Gregory R. Trauthwein
trauthwein@marinelink.com

Contributing Writers
Justin Manley, U.S.
Elaine Maslin, Aberdeen
Tom Mulligan, Ireland
Claudio Paschoa, Brazil
William Stoichevski, Oslo

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, Information Technology Services
Vladimir Bibik
bibik@marinelink.com

Circulation
Kathleen Hickey
mtrcirc@marinelink.com

Advertising
Vice President, Sales and Marketing
Rob Howard
howard@marinelink.com
Tel: (561) 732-4368 • Fax: (561) 732-6984

Advertising Sales Manager
Mike Kozlowski
kozlowski@marinelink.com
Tel: (561) 733-2477 • Fax: (561) 732-9670

Editor's Note

I know it's still early, but there is a general good feeling that 2019 will be a rebound year for a number of maritime, offshore and subsea sectors, particularly in the offshore energy markets, which includes offshore wind. We were recently in Aberdeen for Subsea Expo and in New Orleans for Underwater Intervention, and there is a palpable feeling of good things to come. Next up is Oceanology International Americas 2019 in San Diego, the second edition of this Oi brand in San Diego, and it is significant as it is a 50th anniversary celebration for Oi, which debuted in 1969 in Brighton, England. In select copies of this edition you will find a commemorative *"Oi 50th Anniversary"* publication which tracks the evolution of not only the iconic exhibition and conference, but also the parallel trajectory of subsea technology. *(If you don't see a copy with your edition, drop me a line on my email below and I'll send one out).*

This project, which will culminate in a second commemorative publication to be produced with the March 2020 edition of *MTR* and distribute at Oi London 2020, was particularly instructive as it clearly demonstrates the leaps and bounds in this sector. Special thanks goes out to Elaine Maslin for her months-long effort to produce the main feature, as well as thanks to Kevin Hardy, a regular contributor in our pages, for his personal and thorough narrative, starting on page 10, covering the industry's development from the start of his career in 1972.

Starting the year with our 'vehicles' is most appropriate, as surface and subsea vehicles of every shape and size remain central to the work being done in, on and under waterways around the world. This edition is packed with news, insight and analysis of the ever-evolving sector, starting on page 26 with Justin Manley's overview of significant technological milestones of the past 25 years.

Gregory R. Trauthwein
Associate Publisher & Editor

MARINE TECHNOLOGY REPORTER
www.marinetechnologynews.com
Vol. 62 *No. 1*
ISSN 1559-7415
USPS# 023-276
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.

Subscription:
To subscribe please visit
www.marinetechnologynews.com

Authors & Contributors

Adams

Hardy

MacPherson

Manley

Maslin

Stoichevski

Adams
Leon Adams is Vice President – Sales in Lithium and Lithium Ion battery solutions, product definition, and technical customer support. Leon is a member of MTS, SUT, and IEEE. Leon holds a MBA and a BS in Engineering Physics.

Hardy
Kevin Hardy is President of Global Ocean Design, creating innovative components and subsystems for unmanned vehicles, following a career at Scripps Institution of Oceanography. He is on multiple academic advisory boards, and recently received an honorary Doctor of Science degree.

MacPherson
Donald MacPherson, a leading specialist in propulsion system simulation, is HydroComp's Technical Director, where he oversees all software development and engineering services. A graduate of Webb Institute, he is a Fellow of SNAME and member of its Propulsion Hydrodynamics Panel.

Manley
Justin Manley is a technologist and executive with experience in startups, corporations, academia, and government. At Just Innovation Inc. he supports clients with a focus on unmanned systems.

Maslin
Elaine Maslin is an offshore upstream and renewables focused journalist, based in Scotland, covering technologies, from well intervention and asset integrity to subsea robotics and wave energy.

Mulligan
Tom Mulligan is MTR's science and technology writer based in Ireland. Mulligan was born in London in 1958 and grew up in Manchester, England. He graduated Trinity College Dublin in 1979 with a BA Hons Degree in Natural Sciences (Chemistry). He obtained his Masters Degree in Industrial Chemistry from the University of Limerick in 1988.

Paschoa
Claudio Paschoa is MTR's contributor stationed in Brazil.

Stoichevski
William Stoichevski is an Oslo-based journalist reporting on maritime and offshore energy topics for multiple New Wave Media titles, including Marine Technology Reporter, Maritime Reporter & Engineering News and Offshore Engineer.

EMPOWERING

WORLD LEADER IN UNDERWATER e-ROBOTIC SYSTEMS

SAAB

SAAB SEAEYE

THE FUTURE IS ELECTRIC

'Dipping Sonar'

HELRAS Dipping Sonar Tested on Seagull USV

Photo: Elbit Systems

In a Sea Acceptance Test (SAT) performed by the Israeli Navy, a Helicopter Long-Range Active Sonar (HELRAS) dipping sonar was successfully converted for operation onboard the SeagullTM, Elbit Systems' Unmanned Surface Vessel (USV).

Operating a dipping sonar onboard a USV significantly increases the operational working time and substantially enhances that detection capabilities and the effectiveness of Anti-Submarine Warfare (ASW).

The Seagull autonomous multi-mission USV features switchable, modular mission payload suites and can perform, in addition to ASW, Mine Countermeasure missions (MCM), Electronic Warfare (EW), Maritime Security (MS), Hydrography and other missions using the same vessel, mission control system and data links. Seagull offers navies a true force multiplier delivering enhanced performance to naval operations, reducing risk to human life and cutting procurement and operating costs.

www.marinetechnologynews.com/news/helras-dipping-sonar-onboard-585694

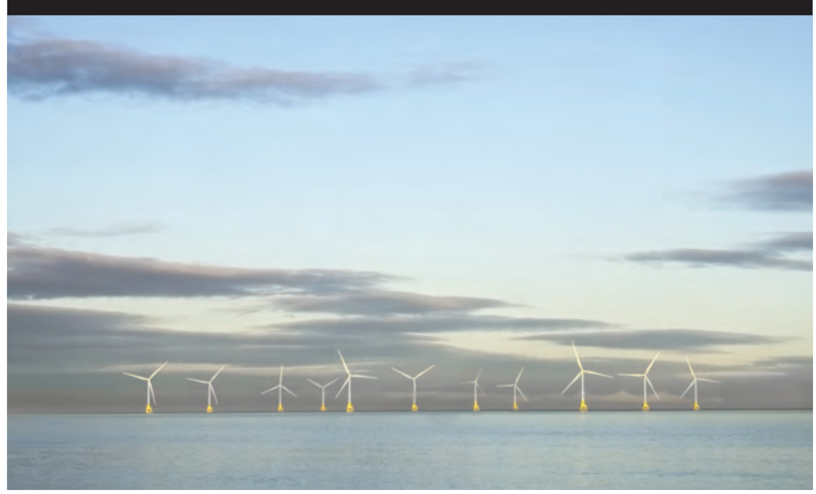
Meet the SeaRaptor 6000m AUV

Teledyne Gavia

Teledyne Gavia will introduce its new 6000 meter rated AUV, SeaRaptor at Ocean Business in April. "In SeaRaptor, the Teledyne Marine team has introduced a high performance AUV capable of carrying the most advance marine sensors available in the market. We have already delivered our first vehicle and see significant opportunities for SeaRaptor," said Thomas Altshuler, VP and Group GM for the Teledyne Marine Vehicle group.

www.marinetechnologynews.com/news/teledyne-gavia-searaptor-6000m-585582

DOE: $28M for Floating Offshore Wind



© Richard Johnson/AdobeStock

The U.S. Department of Energy announced up to $28 million in funding for a new Advanced Research Projects Agency-Energy (ARPA-E) program, Aerodynamic Turbines, Lighter and Afloat, with Nautical Technologies and Integrated Servo-control (ATLANTIS). ATLANTIS projects will develop new technologies for floating, offshore wind turbines (FOWTs) using the discipline of control co-design (CCD).

www.marinetechnologynews.com/news/available-floating-offshore-585539

NAVIGATOR

A one man navigation and sonar reconnaissance unit

The Navigator, a second generation Sonar Imaging and Navigation system, designed by Shark Marine primarily for MCM and SAR use.

Proven

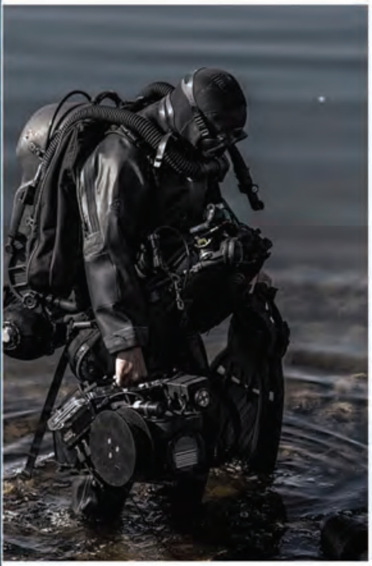
Tested and proven, the Navigator is the trusted choice of 17 Navies, as well as Law Enforcement, Search and Rescue Teams and Scientific Researchers spanning the globe. The Navigator has become a critical part of the Standard Kit and has reshaped SOPs. The modularity of the system and numerous advanced sensors available allow the Navigator be to become a force multiplier, enabling smaller groups to cover more ground efficiently with increased safety.

Mission Ready

The Navigator is the most modular system of its kind, enabling it to be quickly configured for any application.

Intuitive

Shark Marine's DiveLog software controls all operations of the navigator and its accessories, operators need only learn one software to master all their equipment.



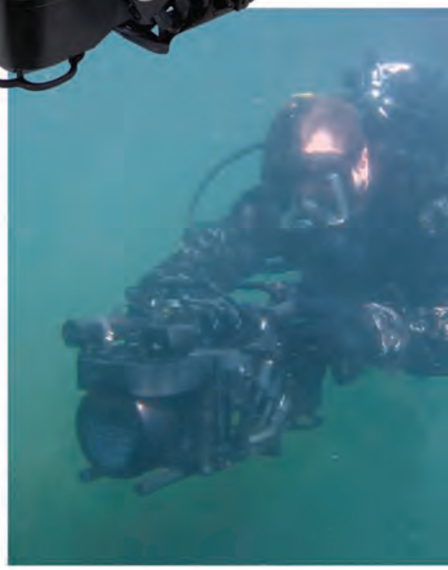


Photo: Oceanology International

Hardy

As MTR *helps Oceanology celebrate 50 Years, regular contributor* ***Kevin Hardy*** *provides an insightful, personal reflection on technology evolution in this sector.*

A number of remarkable changes had already come to pass before I joined the Scripps Institution of Oceanography in 1972. Giant leaps had already occurred; such as the rise of diesel power over sail. The invention of the pinger and PDR opened the deep sea to ready exploration of its topography in the 1950's, though lat/long was still largely determined by sextant, chronometer and Loran, and plotting was largely done by hand. The invention of the o-ring was hailed as a breakthrough in ocean engineering, dramatically improving seal reliability. The French invention and commercialization of the Aqua-Lung provided scientists unprecedented access to their submerged subjects. It also began the training courses to teach safe use of compressed air by divers, which lead directly to LA County, YMCA, NAUI, and PADI certification programs. Following WWII, the U.S. Navy realized the vast importance of oceanography, and began formally encouraging, and investing, in its investigation. Shipboard computing was getting its start as midi-mainframes were made robust enough to handle the strains of ship vibrations and movement, the generator's "dirty power" and higher humidity.

FLIP

The Department of the Navy's **Floating Instrument Platform (FLIP)** begins the process of transitioning from horizontal to vertical by filling ballast tanks in the stern during a cruise commemorating 50 years of continuous service to the scientific community. The 355-foot research vessel, owned by the Office of Naval Research and operated by the Marine Physical Laboratory at Scripps Institution of Oceanography at University of California, conducts investigations in a number of fields, including acoustics, oceanography, meteorology and marine mammal observation.

FLIP was already famous, and SEALAB II had been a major success right off the coast of Scripps in 1965.

When I stepped aboard the RV Ellen B. Scripps for the first time in 1972, our coastal vessels were still using Loran-C for navigation. I recall our first SatNav system, with black punch tape that fed out of one machine to be hand fed into the next. We felt part of the Space Age, knowing a satellite in orbit was communicating directly to us while we were over the horizon from land. We washed our own clothes in a bucket on deck. Mealtimes were always looked forward to, with the hazard of “if you snooze you lose.” Those words to the wise became an adage back onshore for hard work and staying up on the latest work in your field. We’d listen to radio skip BBC World Service in the middle of the North Pacific late at night, their charming accents letting us know the world back home was doing just fine.

Battery chemistries have come along way. The Mallory Mercury cells of the early 1970’s were bigger than a 16-ounce can of soda, and heavy.

One of my first jobs was to build pressure compensated lead-acid batteries for “deep sea tide capsules” for Walter Munk’s group. Our carpenter would make the plywood boxes, open on the top, big enough to fit a car battery. We’d attach PVC extension tubes made by our machinist onto the cat-eye opening of the wet cells. We’d use a huge soldering iron to attached leads to the lead posts, then fill the box with molten tar. The secretaries on the upper floor of the building would politely close their windows until we were done. I was 18, and unsupervised after the first tutorial with a propane burner and the large steel vat of molten tar. Their confidence was well placed, I was just fine, and loved the job. Once the tar cooled, I filled the battery to the cat-eye with battery acid, and topped it with a barrier fluid that was heavier than seawater, but lighter than battery acid. Distressed jeans weren’t in fashion then, too bad.

I recall the fast advancement of marine electronics and sensors. We were still sending casts of many, many copper Nansen bottles, triggered by small weights called “messengers” that fit loosely around the wire and dropped down to trigger the first bottle, which released it’s messenger to drop and trigger the next. We began attaching a CTD to the water rosette and comparing the results of the two. It was hoped we would one day get a digital record instead of transcribing paper logs.

Scripps engineer, Bob Moore, adapted a 4-track then 8-track reel-to-reel recorders to fit inside a 22-inch ID spun aluminum sphere. I was stoked to see the date on the engineering drawing for the aluminum hemisphere was “1946”. The density of the bits on the tape was so coarse that our software engineer could read it using "Magna-See", fine iron filings in an alcohol push spray bottle.

Communications saw rapid change. I once coordinated the purchase of a double barrel capstan winch from Lebus, a U.K. company in Sittingbourne, Kent, England using a teletype located in the Scripps Director's office. Write a message, and a day later get the typed reply. Stop was the period. The U.S. had already been to the moon at that point. One shipmate was a ham radio operator, and we'd try to make a phone patch from sea on particularly long expeditions. Counter-to-counter at the airport preceded FedEx. The advent of Fax was exciting. It was like a copier, with the scanner here, and the printer somewhere else. Now we scan and attach a pdf. Long distance phone calls were big deal, dialing "00" for the international operator, and requesting a person-to-person call. Now we have cell phones and VOIP Skype, and the world is just around the block.

Mechanical drafting was advanced by the invention of the drafting arm over the T-square and triangles. Then came CAD. And CAE. Scientist-engineers at Scripps, Jean Filloux was one, made their own underwater connectors as that industry hadn't matured yet. Frank Snodgrass had a rubber vulcanizing press to make his own underwater cables splices.

Electronics continued to miniaturize. My first semester of college included a class called "Theory of the Slide Rule". "Calculators" were big heavy metal things. The HP-35 blew everyone's mind, then their budgets. Discrete electronics became integrated in little chips with a particular function, and logic design stood shoulder-to-shoulder with old school discrete electronics. The new IC's ran on low voltages with minimal current. Instruments started to shrink as a result, while their ability to resolve and record data intensified. The golden age of mechanics was having some of its realm re-assigned to the expanding world of electron flow devices. Some favored "pressure protected" circuits, others favored "pressure compensated". Each had their lists of what worked and what didn't. I was in heaven with it all.

I still recall the old Scripps machine shop, the smell of cutting oil as you came in the front door, the material racks holding of all kinds of metals in every shape. They had a 16-inch battleship shell converted to a pressure test chamber. The shop was run by a short, barrel-chested supervisor everyone just called "Moon." Moon was an expert welder, we thought he could weld plywood with dowel rod for the filler stick. He instinctively knew how to make things work in saltwater, and he loved cigars. People like Moon belong in every generation.

The shop was run by a short, barrel-chested supervisor everyone called "Moon." *Moon was an expert welder, we thought he could weld plywood with dowel rod for the filler stick. He instinctively knew how to make things work in saltwater, and he loved cigars.* **People like Moon belong in every generation.**

Engineering materials, especially plastics, made wonderful advances. PEEK, fiberglass, delrin, and a host of others became as common in the shop as the marine-grade aluminums. Synthetic ropes, from nylon and polypro, to Kevlar and Spectra, have made working at sea a bit kinder. We worked with industrial companies to improve their syntactic foams.

Inventive scientist-engineers like Professor John Isaacs found surplus military nose cameras, once used to confirm a fighter plane kill, and turned them into deep-ocean cameras. With a natural flair for showmanship, he called it the "Monster Camera", and his pictures of deep macrofauna appeared on the cover of Scientific American. The Isaacs' cameras were used for biology, geology, and even deep water tide studies, were currents are so slow they couldn't turn a rotor, but could carry a puff of dye, photographed every 5 seconds, providing the vector components of speed and direction. Today we thrill at the images lit by LEDs and captured by CCDs, recorded on SSHDs. Still, some things will always be part anyone's maritime experience, like a shackle, a Danforth Anchor, and a bowline knot. Good lessons of basic seamanship are passed down while at sea, like how to approach a buoy on the surface, given wind, swell and current.

There will always be the midnight -0400 watches, mid-rats (midnight rations, the fourth meal of the day on a USN vessel), black coffee, and the vast Milky Way the stretches from horizon to horizon on a clear dark night far from land. There is also a brotherhood of the sea, a family we call "shipmates", or "mates" for short. At sea we look out for one another, as the nearest land could be four miles beneath the keel, and the nearest hospital 4 days away. With few words, we caution the bight in the line, the load swinging overhead, the wet deck, the Captain's bad mood. All the ways we keep an eye on each other at sea aren't forgotten when we come ashore.

Teledyne Marine

Surface to Seafloor

Unmanned Vehicle Solutions for Every Budget and Application

See us at OI North America Booth# F51

TELEDYNE MARINE
Everywhereyoulook™

www.teledynemarine.com

Subsea Electrification

As subsea power needs evolve, so to must the batteries that provide the power.

By Leon Adams, VP, Southwest Electronic Energy

Operators of autonomous underwater vehicles (AUVs) need longer survey runs, deeper dives, and lighter batteries, which result in lighter units in the water. Remotely operated vehicle (ROV) teams require electric-powered manipulators, high voltage and high power, and light batteries.

Desires for manned underwater vehicles (MUVs) include safe operations, deeper dives, longer observation times, and lighter units. The oil and gas industry at large demands electronic control, electrical drives, precision and condition based monitoring feedback, and long-life sensors and monitors for their deepwater systems.

In short, innovative subsea applications are getting smarter and going untethered…and untethered subsea operations require batteries that are safe, smart, provide more capacity, deliver more power, are smaller and lighter, longer life, and highly reliable.

For years, most electrical subsea operations were tethered, powered by umbilicals, which are costly, constraining, and require significant lead time. Untethered subsea vehicles used sealed lead acid, which made them heavy and bulky, or batteries contained within 1 atmosphere pressure vessels, which can be expensive and heavy.

Six years ago, Southwest Electronic Energy Corp's SeaSafe battery brought revolutionary changes to the market. The first commercial pressure-tolerant lithium-ion polymer subsea battery pack known as SeaSafe became available in 2013 after SWE worked on the design in conjunction with Woods Hole Oceanographic Institution. The radically lighter and smaller

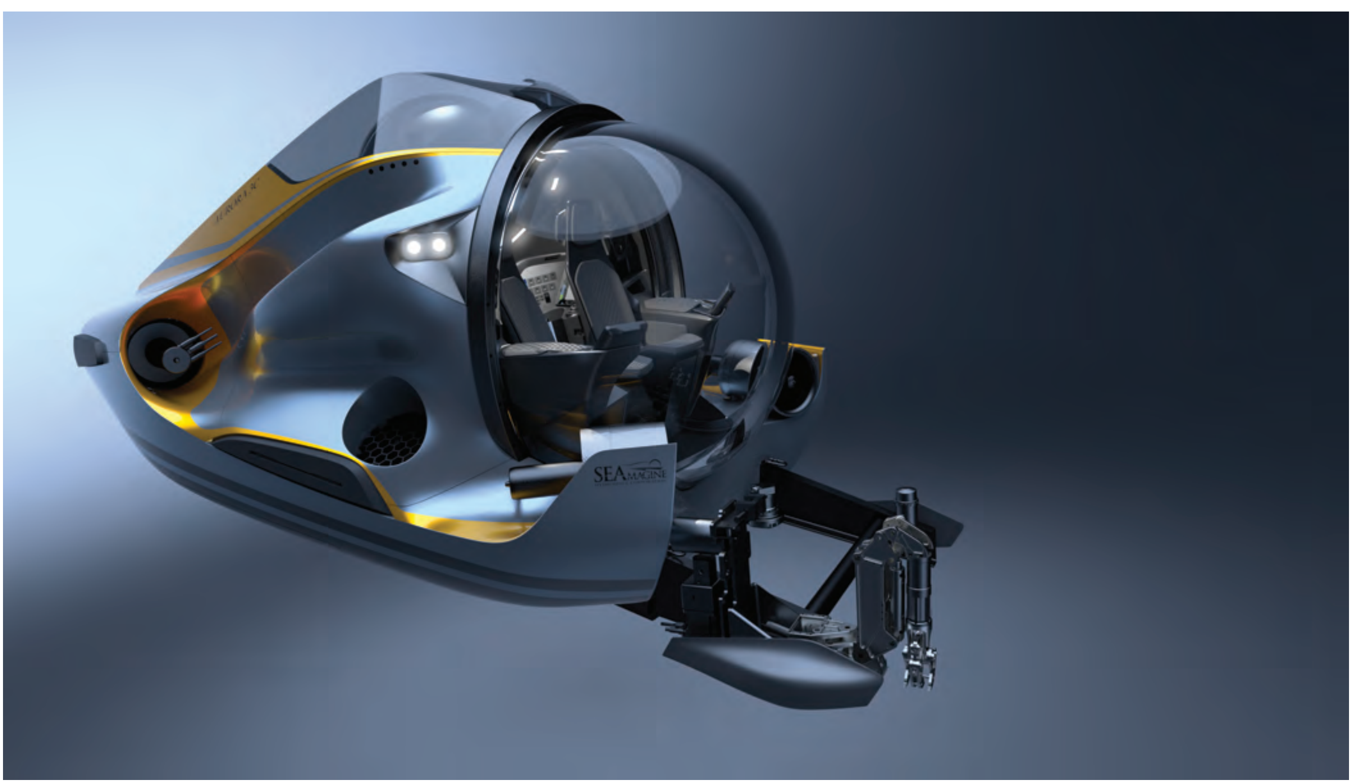


Photo courtesy of SEAmagine Hydrospace Corporation


Riptide set out to change the undersea vehicle market by combining best in class hydrodynamics, ultra low power processing, and game changing new energy technology, while significantly reducing vehicle costs. To accomplish this, we introduced the small, yet highly-capable micro-UUV.
And now, the Family just got
BIGGER
Introducing the Riptide Family of Low-Logistics, Man-Portable UUVs
Riptide
Micro-UUV
4.875″ Diameter
~25 lbs
300m rated
Riptide
1 Man-Portable UUV
7.5″ Diameter
~65 lbs
300m rated
Riptide
2 Man-Portable UUV
9.375″ Diameter
~120 lbs
600m rated
Riptide
Autonomous Solutions
Email: info@RiptideAS.com • Website: www.RiptideAS.com
Phone: +1 617-820-4586 • Address: 36 Cordage Park Circle, Suite 330, Plymouth MA, 02360

battery delivered efficiency gains in installation times in addition to vastly improved performance.

About four years later, SWE made available the next generation of the battery pack. The SeaSafe II, available since 2017, incorporated lessons learned, reliability improvements, and American Bureau of Shipping (ABS) Certification. The powerful, pressure tolerant SeaSafe II battery packs are easy to install in a pressure balanced oil-filled (PBOF) container, which is smaller, lighter and lower cost than a pressure vessel. In response to industry demand to eliminate the PBOF container, SWE developed the SeaSafe Direct, which has been available since 2017. SeaSafe Direct is convenient to use as it can be placed directly into the water without requiring the PBOF container.

The SeaSafe II and SeaSafe Direct are powered by large lithium-ion polymer cells that are specially engineered into modules managed by the BMS to provide 30V at 28Ah or other size options. They are able to operate in water depths to 6,000 meters. Multiple SeaSafe batteries can easily be connected together to meet the voltage and power needs of various applications.

These autonomous battery packs are easy to use and are designed for use in subsea vehicles, oceanographic systems, and deepwater oil and gas infrastructure. The batteries have been used in short-duration, high-power demand applications and long-duration, low-power demand situations. Applications include autonomous underwater vehicles for propulsion, control, and instrumentation; in remotely located infrastructure equipment for valve control and pipe shearing; and in oceanography sensing set-ups such as those for monitoring the salinity and temperature of ocean water over a period of time.

Compared to lead acid batteries, SeaSafe battery packs – weigh one-quarter, deliver longer mission times, provide up to four times more energy, and can take thousands of charges. SeaSafe battery packs also function for up to eight times the cycle life of traditional sealed lead acid batteries, which may provide many years of service, and eliminate classic and costly battery failure headaches.

Meeting customer needs

An example user of SWE SeaSafe II is SEAmagine, dedicated to the personal submarines industry since 1995. This private submersibles company has demonstrated the safety, utility, and dependability of its submarines. To support this, SWE SeaSafe employs its patented Battery Management System within every SeaSafe II Battery Module to ensure safety and dependability unsurpassed in the industry. For vehicle assurance, SEAmagine personal submarines are classed A1+ by the American Bureau of Shipping (ABS). As such, SWE SeaSafe II battery modules are ABS Certified in support of this requirement. Further, for SEAmagine, vehicle geometry matters…their innovative Aurora technology is a revolutionary approach to the design of personal submersibles, maximizing the field of view of the spherical cabin and providing an unparalleled unobstructed vista. SWE SeaSafe II Battery modules enable this vista with battery geometry ¼ the size of some competing batteries yet maintains or expands vehicle battery energy capacity. Reliability matters to SEAmagine. SWE SeaSafe II delivers on reliability with up to 8X the life cycle of competitive batteries. SEAmagine modularity and usability needs are met via the configurable battery sizing and subsea pressure tolerant ease of use of SeaSafe II, which simplifies battery configuration and eliminates the weight, size, and cost of a battery pressure vessel. Finally, SEAmagine stands 100% behind all its submersibles and its professional services…as does SWE stand 100% behind SeaSafe II to SEAmagine, delivering them top service, quality, and reliability.

The case for safety

Some are leery of using lithium-ion batteries in a subsea setting. The SeaSafe product line was designed for extreme safety and autonomy. They are fully polyurethane potted in marine-yellow polymer molded cases and completely sealed off from the elements.

Each module includes SWE-patented Battery Management System (BMS) to safeguard the battery pack. The BMS assists with condition-based monitoring programs. The integrated BMS automatically manages and tracks the safety, reliability, charge and discharge of the batteries and reports technical information on demand. Having immediate feedback on the status of the battery system enables one to confidently respond to an emergency requiring battery power.

The batteries function automatically and safely, and the operator does not require experience to use the batteries. After completing a series of tests, ABS has certified the SeaSafe batteries available to configure in various voltage size configurations.

SeaSafe II battery packs are flexible in sizing, as SWE can customize a battery pack solution to customer's specific product requirements. With several hundred industry-leading customers worldwide, SWE has designed and delivered over thousands of custom battery systems with top service, quality, and reliability.

About the Author

Leon Adams is Vice President – Sales in Lithium and Lithium Ion battery solutions, product definition, and technical customer support. Leon is a member of MTS, SUT, and IEEE. Leon holds a MBA and a BS in Engineering Physics.


It's easy to search the harshest of environments
safe and quickly with a JW Fishers commercial grade ROV
Air bubble trapped under ice
- Highly Portable
- Commercial grade
- High power LED lighting
- 1,000' depth capability
- (4) high output motors
- Pan & tilt front AND rear cameras come standard
- Starting at $20,995
JW FISHERS
JW Fishers Mfg., Inc
(800)822-4744
(508)822-7330
Email: info@jwfishers.com
www.jwfishers.com


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

Contemporary UUV Propulsor Design

By Don MacPherson

From the standpoint of vehicle propulsion physics, an unmanned underwater vehicle (UUV) is little different from your personal ski boat or a tanker. It shares the Vessel-Propulsor-Drive system model, which allows a Propulsor to convert Drive energy into thrust for the purpose of moving a Vessel. The basic principles of thrust equilibrium and motion are common to all three, as are the translation of rotational energy into axial thrust by the central element of the system – the Propulsor.

Not shared by different vehicle types are the constraints and design objectives that are unique to each vehicle's mission. For example, a ski boat may need high thrust at towing speeds and is willing to give up potential top speed to achieve this mission requirement. Its transmission ratio and propeller characteristics are designed for this purpose. A tanker may need its greatest efficiency at the "speed of business" for the greatest financial return. Or it may additionally have a constraint for emissions or fuel reduction, requiring a compromise in the design of the propeller.

Underwater vehicles have their own set of propulsor design requirements related to their various missions, such as battery life (or greatest distance traveled for the battery budget), maximum body diameter, minimum operational speed, consideration of shrouds or nozzles for hydrodynamic efficiency or safety from propeller contact, or reduction of noise to ensure quiet operation for data gathering. This is the setting for our UUV propulsor design work at HydroComp, and it starts with a client interview to glean the really important information for a successful design project.

The Vessel-Propulsor-Drive model is a good framework for such discussions.

Vessel

The typical UUV is a body-of-revolution hull form (also called an axi-symmetric form) that has a nose, body, and tail. For the sake of maximum internal volume for equipment, some vehicles have a very short nose and tail. As you might expect, there is a certain drag penalty for a blunt nose and a propulsion penalty for flow into the propulsor that is not axial but along a steep slope. Part of our work is to balance the different part of resistance – wave-making or pressure drag versus the frictional or viscous drag – to get the least resistance-

A specific submersible vehicle module provides robust prediction capabilities for torpedo-like UUV hull forms.

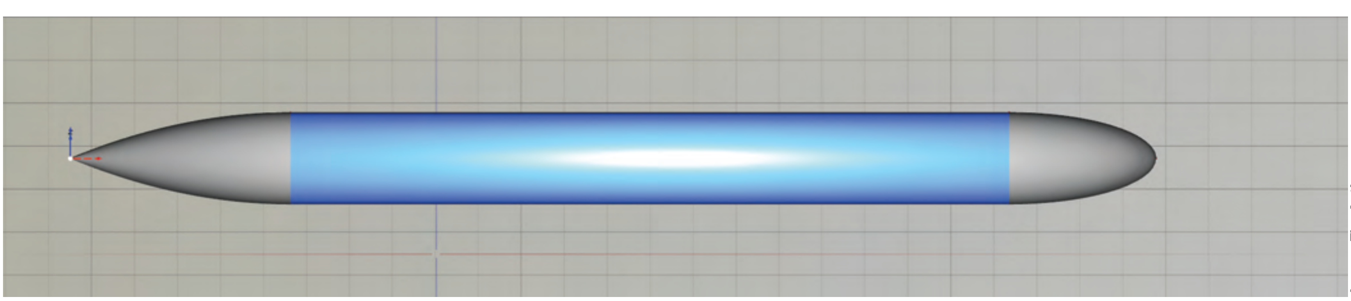


Image: The Author

to-volume outcome. Actually, that's not completely true. We really want a least power-to-volume outcome, and the tail geometry will greatly influence a propulsor's ability to develop useful axial thrust from the rotational energy.

Therefore, many propulsor design projects start with prediction of a vehicle's drag and hull-propulsor coefficients (wake fraction and thrust deduction) using the NavCad® software for hydrodynamic and propulsion system simulation. A specific submersible vehicle module provides robust prediction capabilities for torpedo-like UUV hull forms.

Drive

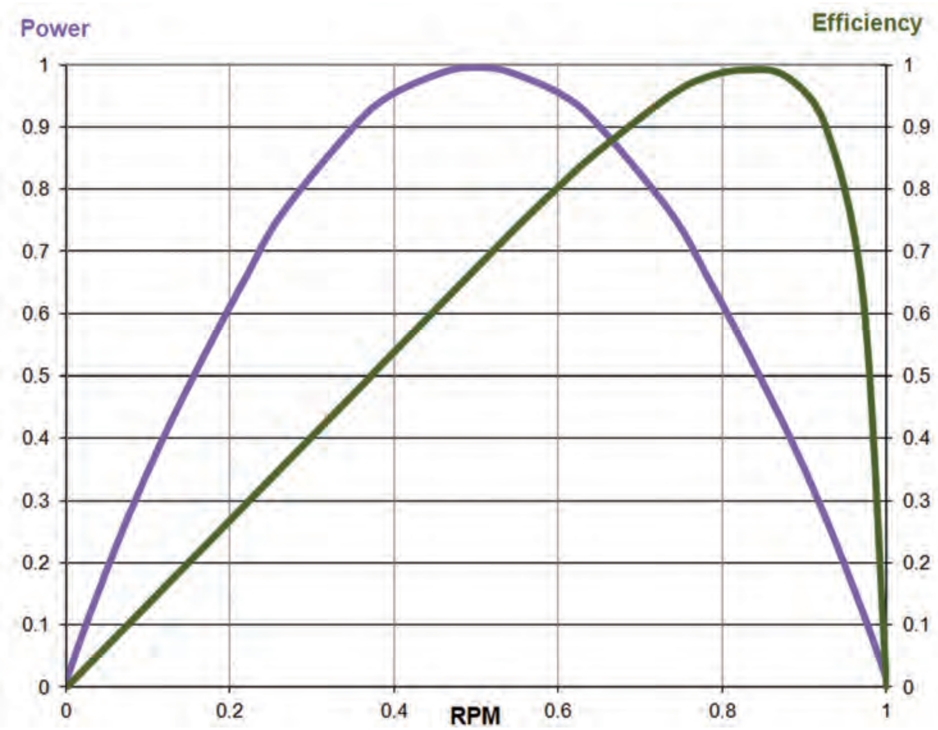
On the other side of the Propulsor is the Drive, which will typically be an electric motor. Motors vary in electrical characteristics, but the critical data for propulsor design are its mechanical output power-RPM curve at the shaft. The "upstream" electrical input power is important, of course, and provides an operational constraint. We characterize the input electrical power with the motor efficiency curve, which helps answer the question: what is our optimum target RPM range if greatest battery life is the highest priority? On the other hand, it is the shaft's power-RPM curve that tells us the RPM for the maximum possible shaft power and, by extension, the RPM for maximum potential propulsor thrust and vehicle speed.

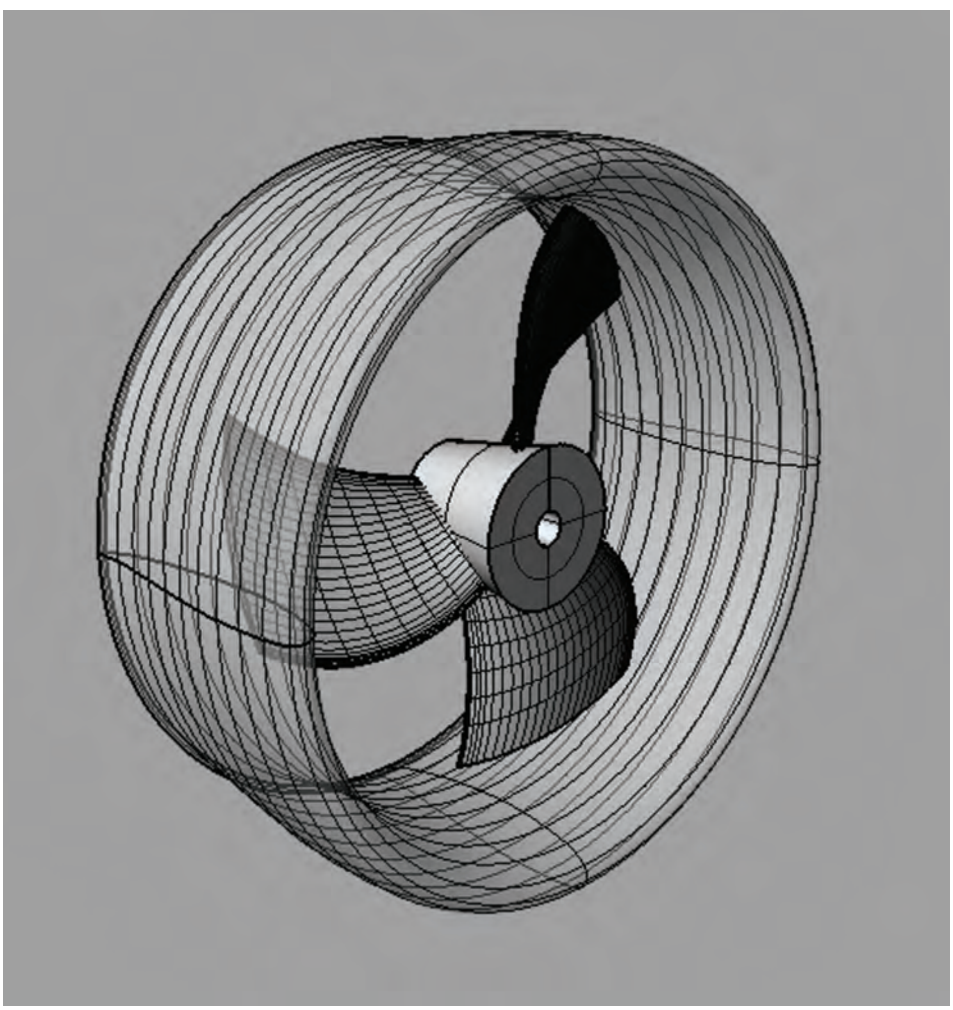
As you can see from the representative motor curves of shaft power and electrical efficiency versus RPM, the highest potential power rarely (if ever) occurs at the highest electrical input efficiency. (see chart next page). So, we often have to define the RPM design point as a compromise that gives neither the higher power output nor the best electrical efficiency.

Also relevant to any discussion about motor-driven UUVs is that shaft RPMs are almost always substantially too high for optimum propulsor operation. It is not uncommon to see some form of gearing to achieve best propulsor performance – or to accept that the propulsor may be operating with mediocre efficiency.

Propulsor

You will note the use of the term "propulsor" rather than "propeller". This is to reinforce the concept that a nozzle and propeller (as found on most UUVs and often called the vehicle's "thruster") is an interactive unit, the Propulsor. Propulsor





As you can see from the representative motor curves of shaft power and electrical efficiency versus RPM, the highest potential power rarely (if ever) occurs at the highest electrical input efficiency.

You will note the use of the term "propulsor" rather than "propeller". This is to reinforce the concept that a nozzle and propeller (as found on most UUVs and often called the vehicle's "thruster") is an interactive unit, the Propulsor. Propulsor design is a combination of finding the best propeller and nozzle (also called duct or shroud) while keeping track of their interaction. In other words, you must use design tools that include this interaction, such as NavCad for system modeling or PropElements for propeller-nozzle component design.

design is a combination of finding the best propeller and nozzle (also called duct or shroud) while keeping track of their interaction. In other words, you must use design tools that include this interaction, such as NavCad for system modeling or PropElements® for propeller-nozzle component design.

In all UUV propulsor design projects, one universal objective is to develop a geometry that generates the highest thrust-to-power ratio (its efficiency), which we achieve using well-established practices. It is generally the influence of external design drivers that can make successful UUV propulsor design so challenging. For example, the RPM can be too high (as noted above). Geometric constraints can limit the maximum diameter (to ensure it remains within the body diameter) or they can influence the design to account for slope of the vehicle's tail.

It is important to take a moment and mention the implications of UUV propulsor manufacture. There is substantial discussion in the press about additive manufacturing (AM) for propellers. While this may be attractive from a financial and deliverability standpoint, we must take care that performance is not compromised by inappropriate surface texture (which can have a huge influence for propulsor of the small size found on most UUVs), fatigue strength failures, or by hydro-elastic flexure in the blade. HydroComp has developed successful practices for the use of AM for small propulsors through a variety of in-house research projects.

Beyond these practical design considerations, one of the most interesting contemporary design drivers the topic of radiated noise. As part of a broader sustainability initiative, HydroComp has developed expertise in the prediction and mitigation of propulsor hydroacoustics (the term that captures noise and vibration). This knowledge is also being made available to other naval architects and engineers as new hydro-acoustic features are developed for our tools. A project's sensitivity to noise is now always part of discussion with our UUV propulsor design engineering clients.

All hydroacoustic excitation is from mass fluctuation (the periodic movement of fluid mass). Propulsor-driven hydroacoustics is generally caused by variations in the low-pressure zones of the propeller as it rotates in-and-out of "shadowed" regions, such as behind a strut or control fin. Part of the fluctuation is simply from the change in flow direction around the blade caused by the varying inflow, but more significantly by the rapid expansion and collapse of cavitation on the blade. Each of these is evaluated as part of our propulsor design, with mitigation as needed by changes to a blade's outline and its camber-pitch distribution.

Excessive hydroacoustic excitation – and transmission – can also be aided with a creative nozzle design. Using our background in nozzle performance modeling, we can consider if particular noise-quieting nozzle geometry can offer the necessary suppression, as well as any loss of propulsor efficiency.

So, while UUV propulsor design has its collection of unique challenges, is it still just a component task within a larger system problem. It can offer a satisfying engineering challenge, one that can be successfully completed with a little care, proper tools, and practical experience.

About the Author

Donald MacPherson, a leading specialist in propulsion system simulation, is HydroComp's Technical Director, where he oversees all software development and engineering services. A graduate of Webb Institute, he is a Fellow of SNAME and member of its Propulsion Hydrodynamics Panel.

L3 ASV Delivers to the Royal Navy

Image: L3 ASV

L3 ASV delivered a long-endurance autonomous vessel known as the C-Enduro to the Royal Navy, to be used for military data gathering trials by the Mine countermeasures and Hydrographic Capability (MHC) program as the Navy seeks to exploit autonomous technology.

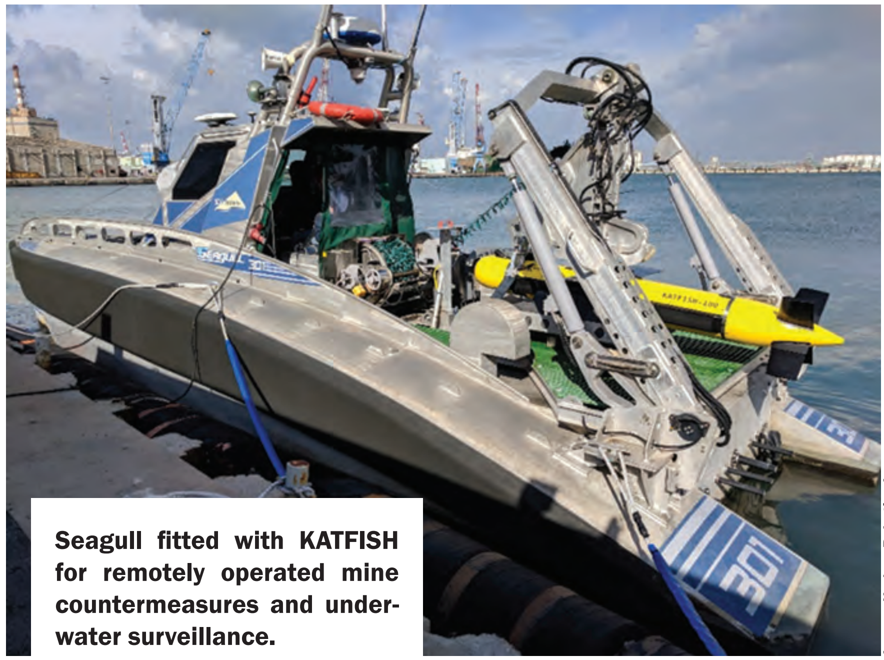
The 4.8-m autonomous vessel is equipped with 10 sensors combining scientific and hydrographic survey equipment. The vessel operates using L3 ASV's proprietary control system, ASView, and is fitted with L3 ASV's advanced autonomy package, ensuring situational awareness and smart path planning. ASView enables a range of autonomous control modes, including line following, station-keeping and geo-fencing.

"The different ways in which the C-Enduro can be operated will allow the Navy to test and develop the ability of an autonomous Unmanned Surface Vessel (USV) to effectively gather important hydrographic data and potentially form part of a future capability to be delivered by the MHC program," said Alex du Pre, MHC Team Lead at Defense Equipment and Support.

This project marks the fourth delivery of a C-Enduro vessel, and previous successful missions include an 11-day over-the-horizon marine science mission north of Scotland for the National Oceanography Center.

Kraken's KATFISH

Sea Tests with Elbit Systems



Seagull fitted with KATFISH for remotely operated mine countermeasures and underwater surveillance.

Image: Kraken Robotics Inc.

Kraken Robotic Systems completed a series of sea tests of its KATFISH towed Synthetic Aperture Sonar system with Elbit Systems, an international defense contractor based in Israel.

Elbit Systems has developed a USV named Seagull, a multi-mission USV platform boasting high autonomy levels and modular features for a wide array of missions. "Elbit Systems' Seagull USV is one of the most advanced ocean drones in the world," said Karl Kenny, Kraken's President and CEO. "With KATFISH integrated on Elbit's Seagull USV, the system can provide remotely operated, unmanned, end-to-end mine hunting operations. With KATFISH, these ocean drones can detect very small objects hidden on the seabed and enter confined spaces where underwater explosives are likely to be hidden. Kraken and Elbit are co-operating on a number of international contract pursuits for KATFISH integrated on the Seagull platform."

Some key objectives realized during the KATFISH tests included:

- Operations in sea states of 3 - 4
- Towing at 7+ knots in shallow 15m water with KATFISH survey depth of less than 6.5m
- Constant 3cm resolution imagery and 25cm bathymetric resolution, in real time
- Area coverage rates greater than 2.1 km2 per hour
- 2-Sigma Target Position Error of less than 2.26m (95%)
- Remote command and control of KATFISH over low-bandwidth wireless link
- Compressed SAS imagery and bathymetry transmitted in real-time over low bandwidth wireless link
- Survey operations conducted by supervised autonomy from remote shore-based site
- Single operator launch and recovery of KATFISH payload in high sea states

Royal Navy Trials Micro-Robots

ecoSUB has been successfully trialed in the North Sea off Orkney during a marine robot demonstrator mission coordinated by the National Oceanography Center (NOC). ecoSUB is a new type of Autonomous Underwater Vehicle (AUV) developed by Planet Ocean in partnership with the NOC. The vehicles are around 0.5m in length and weigh 4 kg, and are therefore classified as micro-AUVs. Despite their small size, they are capable of diving to 500 m (2500m for ecoSUB-m25) and have sufficient battery power to stay underwater for several hours.

Two of the new ecoSUB-µ5-SVP vehicles were deployed from the Royal Navy's HMS Enterprise during the trial and successfully collected Sound velocity profile data to depths of 100 m.

The ecoSUB-µ5-SVP carries a Valeport time of flight sound velocity sensor which is ideally suited for use on the ecoSUB vehicle. A unique feature of ecoSUB-µ5 is its ability to dive almost vertically, in a spiral with a very small footprint, allowing water column profiles to be captured. Traditional AUVs and gliders have relatively shallow dive angles which means that they need to travel horizontally some distance while acquiring data.

Photo courtesy of Planet Ocean Ltd.

Unmanned Maritime Vechicles

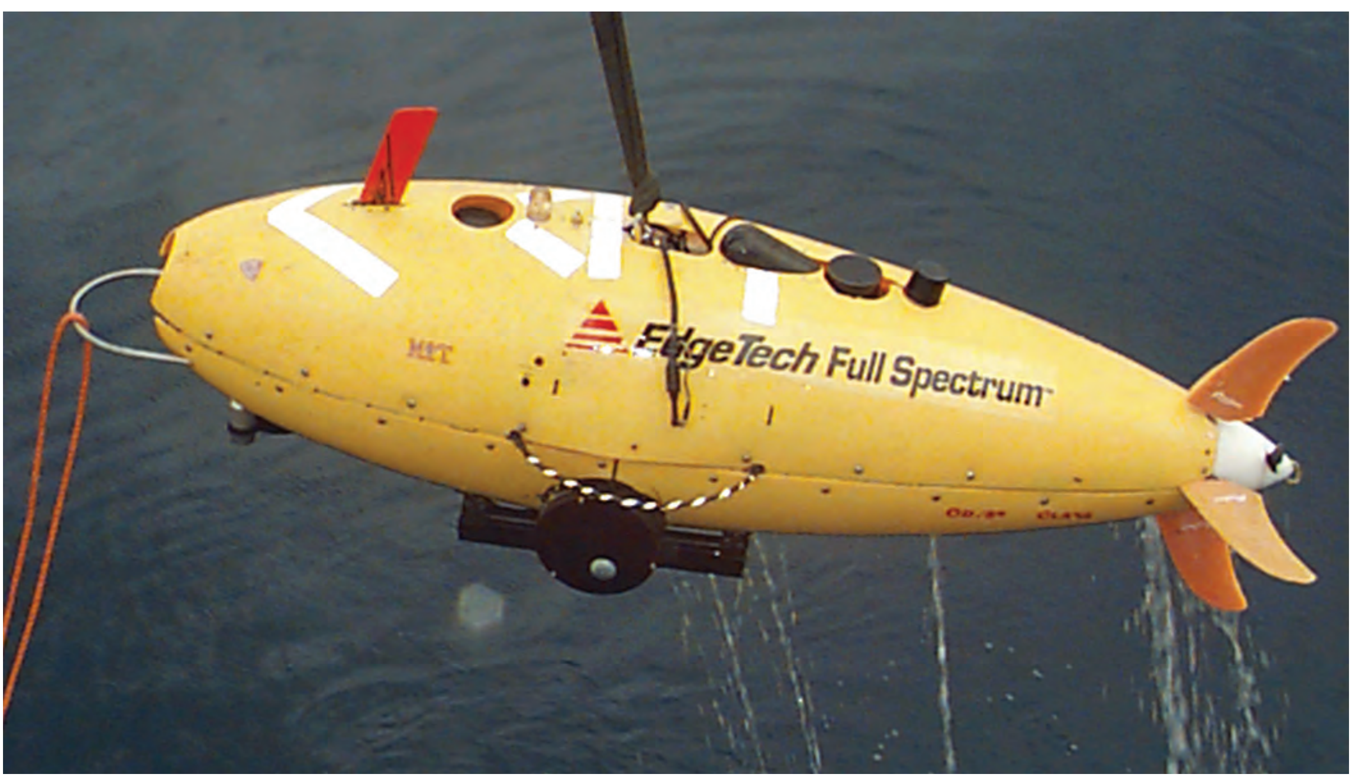
25 Years

Hundreds of Milestones

By Justin Manley

As 2019 begins, the ocean tech community celebrates 50 years of Oceanology International, a global gathering and showcase of the tools and technologies used by maritime industry, science, and defense. In that retrospective spirit it is informative to look to the history of the unmanned maritime vehicle (UMV) community. While there are records of developments in the field as far back as 1957, the modern era traces its roots to the early 1990s. One key source of technology developments was the MIT Sea Grant Autonomous Underwater Vehicle (AUV) Lab which spawned numerous vehicles, launched an industry leader, and trained many engineers now shaping the field around the world. The evolution of AUVs, sometimes known as UUVs, and autonomous surface vehicles (ASVs), sometimes known and USVs, illustrates both technical and commercial influences. As the technology has matured the applications and business impact has grown too.

An Odyssey AUV equipped with an early sub-bottom profiler,



(Courtesy J. Manley)

AUVs Then

In the early 1990s the MIT AUV Lab was working with a vehicle series known as the Odyssey Class. These were roughly 21 inches in diameter and about 2 meters long. They were designed to dive as deep as 6,000 meters but be relatively affordable and easy to deploy. These vehicles supported many science missions including under-ice work in the Arctic and oceanography in the Antarctic. A key program supported by these vehicles, sponsored by the Office of Naval Research (ONR), was known as the Autonomous Ocean Sampling Network. This pioneered designs for docking AUVs. Experiments in seafloor mapping and mine hunting were also conducted during the first ten years of the AUV Lab. In 1997 Bluefin Robotics was founded to transition these ideas into industry, the first of many commercial AUV manufacturers to follow.

The Odyssey technology developments touched upon all domains. The core developments in unmanned vehicle control inspired today's software communities. In particular the Mission Oriented Operating Suite (MOOS) was launched at the MIT AUV Lab in the early 2000s. Other technical developments undertaken were experiments with early acoustic modems and Doppler velocity logs (DVLs). Payload systems were also integrated and evaluated. Early digital side-scan sonars were an important step toward today's survey AUVs. The first integration of a sub-bottom profiler on an AUV was also completed by the MIT AUV Lab during its first decade.

AUVs Now

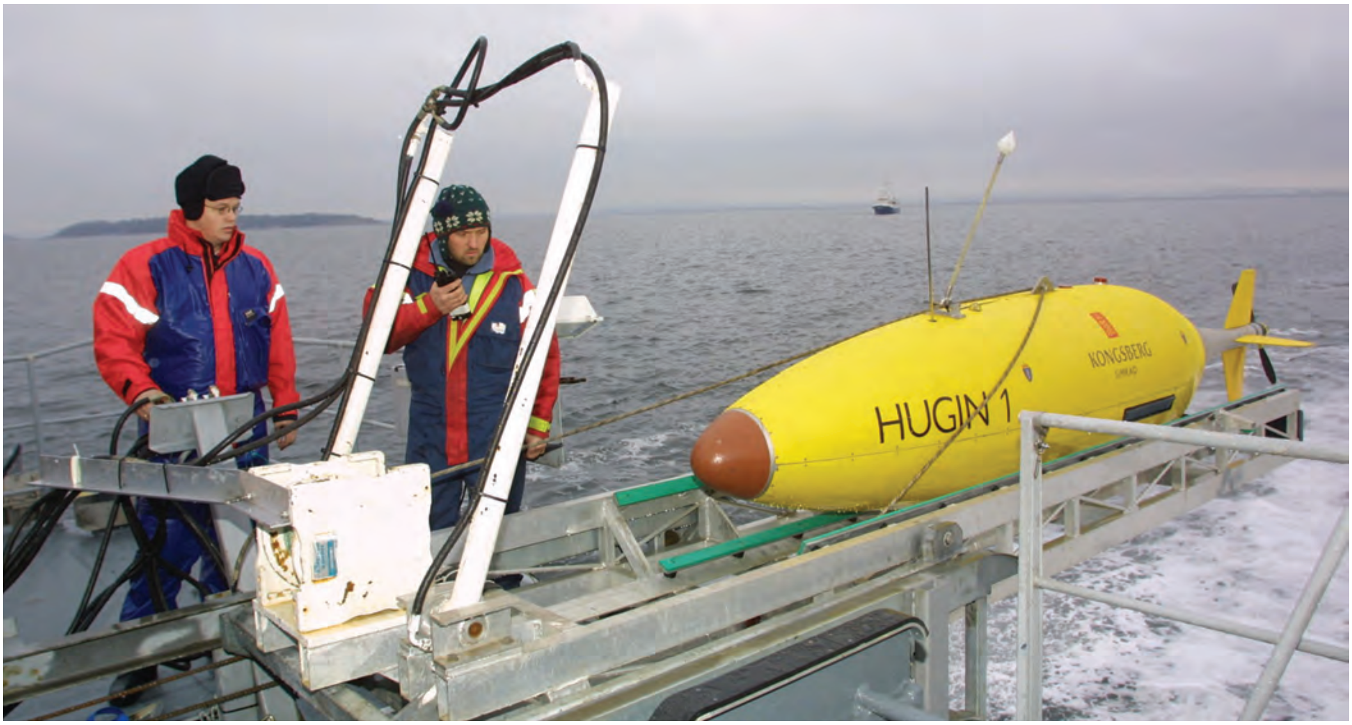
Today AUVs come in numerous shapes and sizes. Technologies that were out of reach 25 years ago are commonplace. The Hugin vehicle is one of the leading commercial vehicles in service today. It is illustrative of the entire community, offering a comprehensive payload sensor suite including side-scan sonar, sub-bottom profiler, multibeam echosounders, magnetometers and cameras. Emerging payloads demonstrated on Hugin include synthetic aperture sonar and laser scanners. The navigation solution for Hugin AUVs uses raw output from an onboard inertial measurement unit (IMU) coupled with other available in-situ sensors processed in real-time using a Kalman filter. These are all significant improvements from the first Odyssey vehicles that carried little more than a temperature sensor and counted propeller turns for undersea positioning purposes.

Commercially Hugin, and its competitors, are serving numerous markets. Military buyers use AUVs for mine hunting and physical oceanography. Science users search for shipwrecks and hydrothermal vents. But the most vibrant commercial sector for AUVs is in offshore energy. Both oil and gas and renewables such as offshore wind employ AUVs for many different types of mission from site characterization & inspection to pipeline inspection. Marine hydrography and 3D pseudo-seismic as well as archaeological studies are also common commercial applications. Today the survey AUV is not just accepted, but expected, in many maritime applications.

With survey AUVs becoming commonplace the emerging frontier for AUVs includes novel concepts enabled by modern electronics, design, and manufacturing techniques. In QinetiQ North America's SEAScout we see a compact, simple approach. Teleynde's Gavia offers modularity for payload and system components, and the Riptide UUV family leverages open source approaches to be especially user-friendly.

QinetiQ North America's SEAScout is a lightweight, A-size, very small UUV featuring a reconfigurable payload capacity that enables it to perform multiple maritime missions such as

A Hugin AUV being launched.



Courtesy Kongsberg

Teledyne's Gavia Modular AUV.

Courtesy Teledyne Marine

QinetiQ North America's SEAScout Mk2 UUV at ANTX 2018.

Courtesy QinetiQ North America

decoy, gateway buoy, neutralizer, data gathering, intelligence, surveillance, and reconnaissance. The latest generation SEA-Scout, is offering enhanced endurance, communications, and navigational accuracy, as well as new payloads. This work builds on the successful integration of an acoustic payload demonstrated at ANTX 2018. This new compact UUV is designed to be readily and easily employed by US Navy sailors without specialized training, simplifying employment on real world missions.

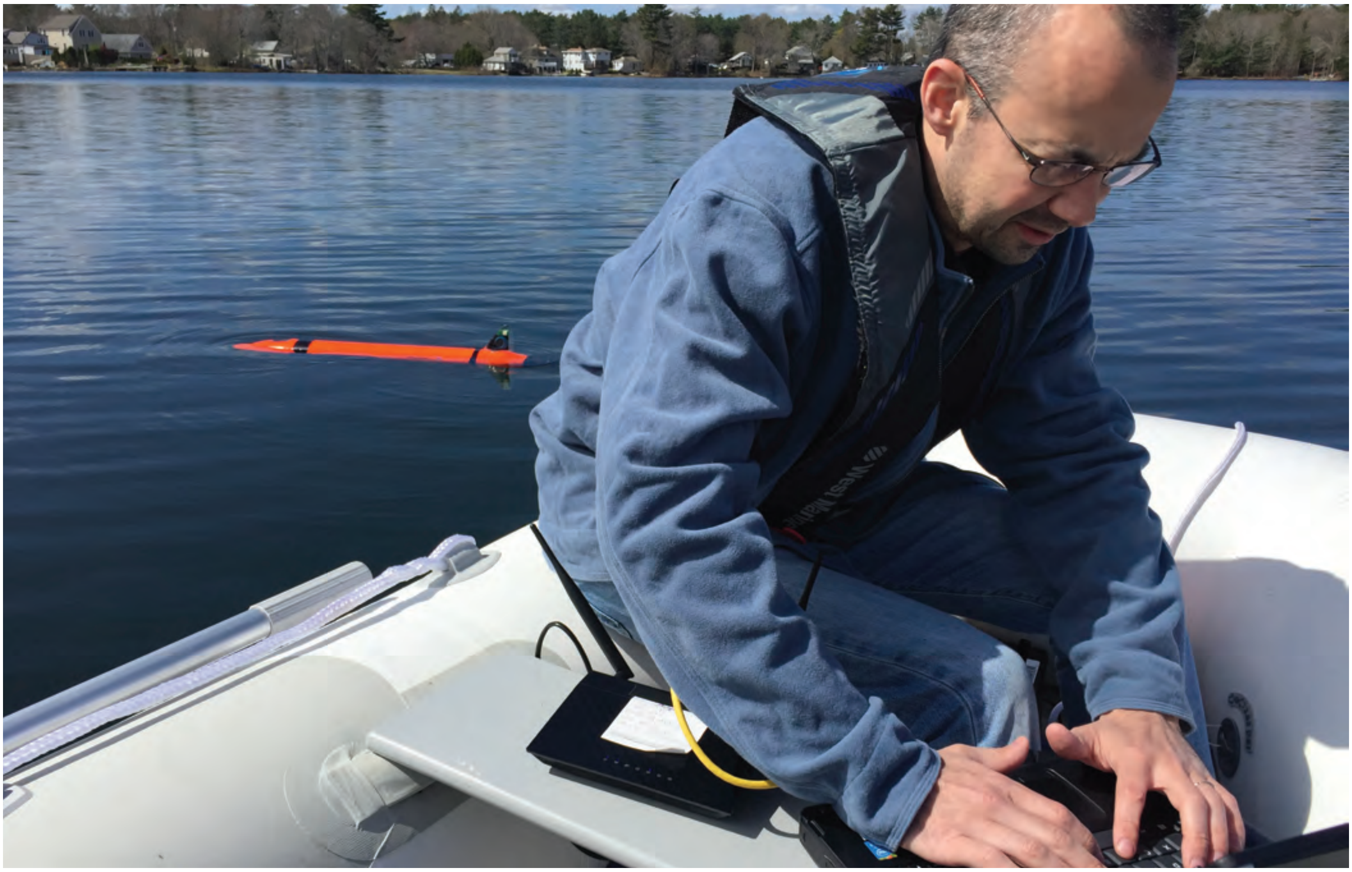
Teledyne's Gavia uses a unique mechanical/electrical design that allows the vehicle to be disassembled into smaller components. This allows the 1,000 meter rated vehicle to be easily deployed around the world. It also provides the opportunity for users of the vehicle to expand their future operations with new payload modules that are backwards-compatible with AUVs built before the payload sensors were available. This has been demonstrated with AUVs delivered in 2008 employing new payload modules built in 2018, a full ten years later.

Riptide Autonomous Solutions has built a family of AUVs. It started with a microUUV and have expanded to larger and deep-rated variants. But it is what is on the inside that matters. Employing the latest developments in electronics and software makes Riptide vehicles especially flexible. Their architecture features open hardware and software interfaces to provide users a reliable and robust platform to advance technology development. This same approach has also allowed the company to rapidly adapt and launch new standard products within 14 months. While this is not quite the pace of consumer electronics, it is very rapid product development. The AUV community is moving quickly into the next 25 years.

ASVs Then

As with AUVs, MIT was a source of early autonomous surface vehicle (ASV) development. There were significant parallels with AUV work. Early prototypes in the 1990s did not use GPS, lacked WiFi, and struggled with payloads. Like the Odyssey AUVs these vehicles used a fully autonomous approach without any vehicle interaction once a mission was launched. One area of early innovation on the surface was the use of internal combustion engines for propulsion. These early ASVs were first inspired by fisheries research, intended as tools to track tagged fish. Eventually the focus shifted to

Riptide UUVs use open architectures to enable users.



Courtesy Riptide

Below: An early ASV prototype. INSET Right: L3 ASV C-Worker 5 Autonomous Vessel.

Courtesy L3 ASV

Courtesy J. Manley

hydrographic survey, which has become one of the most common missions today.

ASVs Now

In recent years ASVs have proliferated, especially small systems for shoreside use. In the domain of ocean-going systems there are fewer players. ASV Global, now L3 ASV, pioneered this area, specializing in the development, supply, and integration of unmanned surface vessel technology. They offer a range of complete USV systems from two to fifteen meters in length. In addition to L3 ASVs' product range the company is undertaking projects to convert ships and small craft for unmanned operations. The wide product range allows ASV to provide varying and proven solutions to the market for operations in an inland, coastal and offshore environments. They have delivered more than 100 autonomous systems to more than 60 customers in 15 countries. Like survey AUVs, ASVs are now a proven tool.

The mission of seafloor survey remains a core application for this technology. In this domain ASV recently announced a partnership with Fugro, a global survey leader, to create the next generation of autonomous vessels for the commercial survey market. Developing this new autonomous vessel solution will help the survey industry reduce offshore staff exposure and increase operational efficiency by making operations safer and more cost effective.

Unmanned Systems: The Future

Since the mid-1990s the internet, software, and sophisticated electronics have transformed life ashore. At sea there have been equally transformative developments. Early AUVs and ASVs demonstrated the potential of unmanned systems to transform ocean operations in all sectors of the blue economy. Early AUVs delivered results for oceanography, today they serve diverse sectors and are a fundamental element of offshore survey. ASVs have evolved from rudimentary near-shore tools to globally-relevant platforms networked to operators thousands of miles away. In 25 years hundreds of new unmanned maritime vehicles have been developed. They have crossed oceans, discovered shipwrecks, found mines, and surveyed hundreds of thousands of miles of seafloor.

Henry Stommel's visionary article, The Slocum mission, was published in 1989. He anticipated fleets of autonomous vehicles roaming the ocean over long time scales and collecting unprecedented new oceanographic data sets. Now, 30 years later, with the ongoing success of unmanned undersea, and surface vehicles, Stommel's vision has been demonstrated, if not achieved.


We Turn Harsh-Environment Challenges into Opportunities
The ocean and its resources are central to life in Newfoundland and Labrador. The ingenuity and entrepreneurial spirit in our province have been instrumental in addressing solutions for harsh-environment challenges faced in key industries such as oil and gas and the fishery.
Visit us at Oceanology International 2019, San Diego, CA
Canada Pavilion, Stand: E41
SubC Imaging
Advanced Underwater Optical Imaging
GRi SIMULATIONS
3D Subsea Simulation
KRAKEN
Seabed Intelligence
pangeosubsea
Sounding Out Risk
SULIS SUBSEA
Unrivaled Image Quality
RUTTER
Enhanced Marine Radar Intelligence (Stand F200)


findnewfoundlandlabrador.com
Newfoundland
Labrador
CANADA

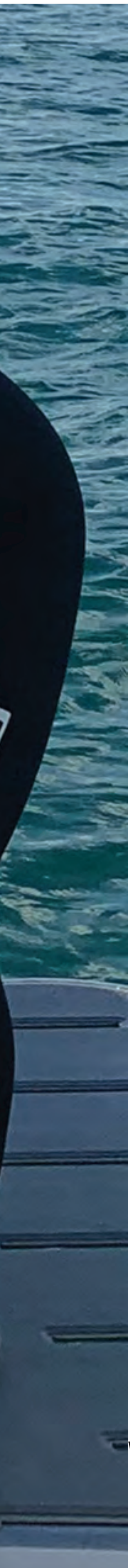
Subse

Ben Kinnaman, CEO, & Marybeth Gilliam, COO, Greensea Systems, Inc.

Photo: Greensea Systems

The Future of

ea Vehicles



Subsea vehicles of every shape and size have evolved mightily in the past few years, as a confluence of communication, electronic and autonomy technologies have conspired to increase the accuracy, duration and efficiency of such systems. *MTR* tapped a few key industry leaders to discuss the path ahead.

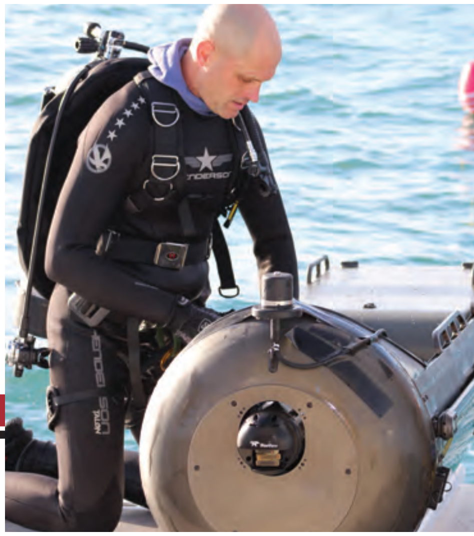
By Greg Trauthwein

"I think there are two current market drivers forcing the industry to develop and adopt technologies that make subsea vehicles more efficient and effective," said Ben Kinnaman, CEO, Greensea Systems, Inc. "First, the market really wants to use miniature vehicles and realize the long-promised potential of these systems. Second, we need to get more value from our human operators."

Kinnaman has a unique perspective as Greensea Systems Inc., which he founded in 2006, is a leader in navigation and vehicle control technology and is the creator of OPENSEA, an open architecture software framework for marine robotics across various vehicle sectors.

"We develop software and hardware that revolutionizes the working relationship between people and machines both on and under the surface of the ocean," said Kinnaman, who, like many in the sector "started working with vehicles as an ROV pilot after leaving a diving career. Now I am focused on what vehicles could be for the next generation of the subsea industry."

Kinnaman has been a leading voice in aiming to change what he perceives as the industry's 'bolt-on' mentality. "Sensor and vehicle manufacturers are selling the dream and the market is buying, but, the old model of technology adoption where we just buy a new sensor and strap it on to an existing system is not going to work," Kinnaman said. "To realize this potential and fulfill what the market is expecting requires the industry to figure out technology solutions for making these systems truly efficient and effective in the hands of the operator. Full integration and task efficiency is the only real path forward for these systems. We have to address how to deliver a system that does what the operator intends it to do, easily."



"The role of autonomy in UUVs is without a doubt the most significant advance in our industry from my perspective ...We are really blurring the lines between "ROV" and "AUV" and minimizing the technical difference between manned and unmanned."

Ben Kinnaman, CEO, Greensea Systems, Inc.

AUVs

"Two years ago I attended a workshop at Rice University moderated by the Subsea Systems Institute where major oil & gas companies, their providers, and underwater vehicle manufactures spent the day generating a development strategy for AUVs for subsea applications," said Bob Melvin, the Vice President of Engineering at Teledyne Marine Systems. "Their number one requests was to make underwater systems that can perform subsea tasks. To reach this goal there is acknowledgement that the commercial sector will need to leverage advances made in the defense sector. But for this to become reality, operators need to be able to trust the AUV will complete its mission and return with useable data, or take an alternate action."

Melvin is a long-tenured industry executive. For the past 10 years he has been responsible for overseeing engineering for Teledyne's autonomous vehicles which includes the Gavia AUVs, the Slocum glider, and recently the SeaBotix ROVs and Oceanscience USVs. Previous to Teledyne, he was the engineering manager at Hydroid where he was also the program manager working with the U.S. Navy EOD team developing the Swordfish version of the REMUS-100.

Energy density and availability is the number one market driver in today's AUV market according to Graham Lester, Senior Vice President, Sales & Marketing, Hydroid. "Customers are looking for improved energy sources to allow for greater endurance and larger payload sensors. Additionally, they are looking for improved underwater positioning and through-water communications. The desire is to move toward providing a sustained presence where we can, not only, sense the environment but can affect it and react to it."

Lester has more than 30 years of experience with military, oceanographic, offshore and hydrographic equipment, including a detailed understanding of underwater vehicles and their applications. He oversees Hydroid's U.S. and international sales and marketing teams, as well as customer service and training. Additionally, he collaborates with other Kongsberg entities to develop growth strategies in the Marine Robotics market.

While technical solutions are obvious points of research and work, overall affordability of systems could be the real growth driver that ultimately makes the AUV market more mainstream.

"Riptide is working with numerous undersea sensor providers to bring new capabilities forward to the market affordably and efficiently," said Jeffrey M. Smith, President, Riptide Autonomous Solutions. "The micro-UUV offers a great deal of flexibility for the payloads it can field, and it has been built in dozens of configurations. With a depth limit of 300m and a standard endurance of over 30 hours on alkaline batteries, it is an extremely capable platform. Riptide is currently in the process of fabricating its first series of deeper rated micro-UUVs."

Riptide Autonomous Solutions entered the AUV market as a disruptor in the small autonomous undersea vehicle space. In 2018, it released the MkII micro-UUV into full production. The MkII micro-UUV was a significant design leap forward for Riptide and incorporated molded instead of previously 3D printed components and a major electronics evolution. Riptide's MkII electronics boards dropped the vehicle's hotel power to 3.8 Watts, providing more power for payloads and greater vehicle endurance. With this electronics update, its was also able to significantly reduce internal wiring, simplifying the design, increasing its robustness and making the vehicle more operator friendly.

ROVs

The ROV side of the vehicle equation is more mature than AUVs, and it too is evolving to take advantage of emerging technology trends. The fact that an ROV is tethered is both a strength and a

"Riptide is working with numerous undersea sensor providers to bring new capabilities forward to the market affordably and efficiently. The micro-UUV offers a great deal of flexibility for the payloads it can field, and it has been built in dozens of configurations. With a depth limit of 300m and a standard endurance of over 30 hours on alkaline batteries, it is an extremely capable platform. Riptide is currently in the process of fabricating their first series of deeper rated micro-UUVs. Stay tuned for more from this innovative micro-UUV developer."

Jeffrey M. Smith, Riptide Autonomous Solutions

Image: Teledyne Marine Systenms

"There is acknowledgement that the commercial sector will need to leverage advances made in the defense sector. But for this to become reality, operators need to be able to trust the AUV will complete its mission and return with useable data, or take an alternate action."

Bob Melvin, Teledyne Marine Systems

UUV Technology Drivers

According to Bob Melvin there are four big tech drivers in regards to UUV development today: communication, navigation, energy, and autonomy.

- **Communication:** Physics are limiting our ability to make a giant leap forward in acoustic communication data rates but the understanding of our current limitations and propagation effects has allowed us to get the most out of what we have.
- **Navigation:** Nav iss become more accurate as aiding using acoustics is now the standard.
- **Energy:** It's going to take a tech breakthrough that solves not only the density issue but safety.
- **Autonomy:** Similar to what an operating system is on PCs, the OS became the most important component on your computer. For UUVs it will be autonomy. At a recent IEEE workshop, the community strongly request vehicle manufactures "open the door" to control. Backseat drivers need more access to sensor data and be allowed to take over piloting. Once access is allowed, third party autonomy packages to do specific jobs can be created to work on multiple platforms.

Image: Teledyne Marine Systenms

weakness, the tether carrying and allowing significantly more power, but also limiting its range and maneuverability.

Since its founding in 1986 Saab Seaeye has pioneered innovations that have helped to transform the underwater robotics industry, including brushless DC thrusters, efficient high-frequency power distribution, intelligent distributed control systems and the use of plastics and composites in vehicle construction, said Matt Bates, Director, Saab Seaeye Ltd

Bates' career has been involved with underwater systems. "After graduating with an Honors Degree in Engineering Systems I began working on underwater systems in the defense industry," said Bates. "It was 25 years ago that I joined Seaeye as Head of Electronics since when I have held various technical and

"The development of high-resolution sonars and lower power electronics, as well as improvements in battery technology. By having a large fleet of vehicles in operation, it allows us to understand what works and what doesn't - meaning we can design and produce more reliable, capable and efficient systems."

Graham Lester, SVP, Hydroid

© Cutrona

management posts and am now Director of Sales and Marketing."

On the ROV side, Bates said "operational cost effectiveness and safety are by far the key market drivers. To achieve this, markets are looking for the best possible system solutions at the lowest possible real cost by seeking UUV systems that satisfy four central tenets: safety; vehicle capability; reliability; and the use of smart technologies.

Blue Robotics' is disruptor in the ROV space, its mission to make low-cost, high-quality components and vehicles to make marine robotics more accessible. "We started with a Kickstarter campaign in 2014 for the T100, an underwater thruster, and have since launched over 200 enabling products including the BlueROV2 remotely operated underwater vehicle," said Rustom 'Rusty' Jehangir, Founder and CEO, Blue Robotics. "Today, we have a team of 30 people in Torrance, CA, where we're designing our products, manufacturing them, and shipping them to thousands of customers around the world."

Interestingly, Jehangir's background is in aerospace engineering and drones. "I'd never made anything related to subsea prior to starting Blue Robotics," he said. "That's led to a steep learning curve but a fresh (and perhaps sometimes naive) approach to what we're doing."

"On the technology side of things, I think things are being pushed forward through the adoption of technology from other industries and bringing it to the subsea space," said Jehangir. "For instance, our company is leveraging a lot of technology, electronics, and software that was developed for the drone industry. By leveraging that technology, we're able to offer capabilities that are years ahead of the status quo but at a lower price. I think we will continue to see that across the industry."

"I feel that the low-cost and open products on the market from companies like Blue Robotics, OpenROV, Riptide AS, and others have made a big step towards making UUVs mainstream," said Jehangir.

Regardless of technology deployed, Bates of Saab Seaeye contends that the ability to address the widest range of underwater tasks opens up the possibility of achieving more across more markets which, along with the general safety drive to reduce manned diving intervention, continues to increase the use of UUVs, said Bates. "The demand to achieve more tasks using the most compact robotic solution possible, comes from a drive to reduce deck space and vessel size and reduce mobilization time and costs, while at the same time being able to work in stronger currents or deeper waters, which comes naturally from compact, more efficient solutions."

There are more market drivers and use scenarios than there are vehicles, and there is no 'silver bullet,' no 'one-size-fits-all' solution. "The various different market segments have some quite specific needs and environments to consider. For example, the high current shallow water nature of renewables installation and IRM work differs from deep water oil and gas construction and intervention applications. Also, nuclear decommissioning activities demand different tasks to be completed, compared to aquaculture or marine science applications - and of course their environments are very different. The market demands a wide range of platforms and a high degree of customization for the specific sector needs.

In this regard Bates counts Saab Seaeye's iCON ecosystem of intelligent robotic building blocks and the development of the Sabertooth hybrid vehicle platform with its autonomous and seabed resident capabilities as good examples of products and capabilities developed specifically to both enable and address these key market demands.

The Path Ahead

While there are obvious differences between AUVs and ROVs, some like Kinnaman of Greensea see the lines of differentiation blurring, particular as au-

"I think things are being pushed forward through the adoption of technology from other industries and bringing it to the subsea space. For instance, our company is leveraging a lot of technology, electronics, and software that was developed for the drone industry."

Rusty Jehangir, Founder, CEO, Blue Robotics

tonomy evolves.

"Autonomy and integration technologies are the main (technology) drivers," said Kinnaman. "Autonomous technologies in ROV systems are driving us to reconsider how we crew offshore operations, enabling plans involving resident systems, and opening the option of keeping crews on the beach versus offshore. Autonomous technologies are also enabling the adoption of subsea vehicles and marine robotic systems by a much broader user group: EOD technicians, Special Operations Forces, first responders, and ship husbandry service providers to name just a few."

But it's not just autonomy in and of itself, rather how that autonomy is built into the bigger picture system, whether its and AUV, ROV or UUV, and including the human elememt, too.

"The role of autonomy in UUVs is without a doubt the most significant advance in our industry from my perspective," said Kinnaman. "Not just the emergence and capability of autonomy, but how we consider, use, and deploy autonomy and autonomous technologies is really important to where we are and where we are going as an industry. We are moving autonomous technologies into vehicles that have always been "remotely operated" or even manned to realize more efficiency and capability. We are really blurring the lines between "ROV" and "AUV" and minimizing the technical difference between manned and unmanned. Autonomy lets us realize smarter more capable vehicles that we can work with in a variety of capacities, whether we supervise them or not. This shift in thought is making UUVs more mainstream because you don't need to be an "ROV operator" or engineer to use them."

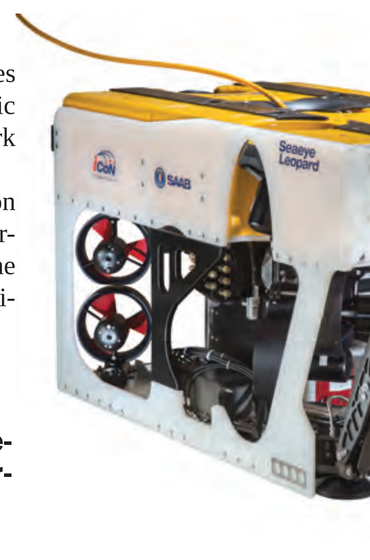
And while much of the attention inevitably shifts to the machines and the technology onboard, Kinnaman is adamant to remember the human element of the man/machine interface.

"The second market driver pushing

Saab Seaeye Case Study

Millions of dollars were reportedly saved for their oil and gas client by Australia's subsea services company, Dive Works, through the imaginative deployment of its Saab Seaeye Leopard electric robotic vehicle. Dive Works conceived a way for the Leopard to undertake a seemingly impossible IRM work scope that previously could only be achieved by larger hydraulic systems or divers.

In what is considered a world's first undertaking, Dive Works maneuvered the Leopard and a 1.25 ton diamond wire cutter, supported by a lift bag, deep inside a platform structure to slice through a meter-diameter steel pipe and remove it from the site. "Our Leopard has completed over 750 dives, it is the most powerful ROV of its size in the world and we continue to maximize its capacity in extreme conditions and on extreme tasks with on-going success," said Andrew Ford Dive Works' managing director



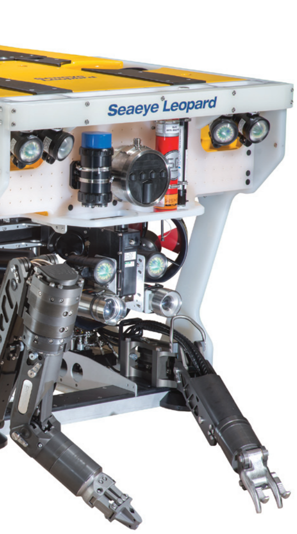
Pictured right: Saab Seaeye Leopard is an alternative to hydraulic systems designed to deliver savings in costs while having the stability and agility to operate in high currents at work tasks inside and around complex structures.

Pictured Far Right: Matt Bates, Director, Saab Seaeye Ltd.

Photo Credit: Jeff Milisen

us to make vehicles more efficient and effective focuses on getting more value from our operators," said Kinnaman. "Our traditional model of working with vehicles was based on a vehicle operations team, pilots and technicians, and subject matter experts (SMEs). As we look to control costs, we are considering reducing the amount of personnel required for vehicle operations and getting more out of a smaller team. So, do we train ROV pilots and technicians to be SMEs or do we train SMEs to be ROV pilots? Or, do we build better vehicles that do not require on-site technicians and that can fly themselves with high-level, task-based, instruction from SMEs? "

"I think ultimate efficiency and effectiveness is offered in the latter, with autonomous technologies playing a more vital role in ROV operations. Having greater autonomy within ROVs will also allow a broader user group composed of operators, who do not have specific training as pilots and technicians, to adopt subsea vehicles as tools to do work in and on the ocean."



AUV Trends are all about Disruption

Missions—it's all a question of missions. The mission decides the payload, battery capacity, size and processing power of an autonomous underwater vehicle, or AUV. King among these is payload, from which market disruption is just waiting to happen. Changing payloads of artificial intelligence, management software, and researcher resourcefulness now combine with entrepreneurial technologists to inject uncertainty into AUV market forecasts.

By William Stoichevski

On a stormy night in an arctic sea, waves of salt water slosh against the hull of a light, unmanned surface vessel. A sleek, yellow "torpedo" is robotically hoisted into the water by the robot davits. As the AUV swims off into the darkness and submerges, a tube rights itself and launches a rocket packing a satellite the size of a softball.

No, it's not General Dynamics's large, drone-launching Marlin AUV just released. It's a writer's impression of the missions now being planned by AUV-equipped oceanographic researchers at Norway-based research community, AMOS. The real mission is about to begin. AMOS will shortly be test-firing tiny, disposable satellites bearing spectral cameras that will also gather and beam back the data gathered by the spectral cameras and sensors of their REMUS-dominated fleet of AUVs. The pocket satellites will instantly process and send to shore data on the contours and algal life above and below arctic ice. The satellites will also help AUVs communicate with other AUVs over a wide area while enriching AUV scans with their own data.

"You can communicate with the AUVs of a networked system and collect that data," says NTNU professor of guidance, navigation and control, Thor Fossen. He adds that the tiny, limited-use scanning and data-collection satellites will actually launch first in the North Sea. He also says it takes "many parts", meaning components and people, to see both sides of an ice flow.

AUV networks

"The more people working on it the better," says Fossen, adding that the costs of AUVs are prohibitive, so researchers build their own payloads. AMOS researchers have just developed their own, "low-cost" spectral camera: "What's hot about this research is that hyperspectral cameras (using chemical calculations) can measure all the colors of our (electromagnetic) spectrum, so it sees what you can't see with your eyes. It can see the kind of metal a plate of metal is or it can look at a coral and see color that you can't see with your eyes."

Martin Ludvigsen, an NTNU professor of marine technology and manager of the AMOS applied underwater laboratory, or AUV Lab, confirms that years of theoretical work creating "data-driven mission plans" for AUVs are now paying off. In September, an AMOS research cruise reached 82.5 degrees North latitude — just short of the North Pole — and deployed a "data-sniffing" AUV. It was the moment Ludvigsen says he realized AUV use in research had turned a corner.

Remote missions

The AMOS team, however, wasn't the first to launch an AUV beneath the arctic ice. In 1982, Canadian researchers sent the AUV Thesueus made by Canadian company ISE under the ice to

Payload-flexible: ISE Explorer 6000 class and ISE 3000 R&D AUVs.

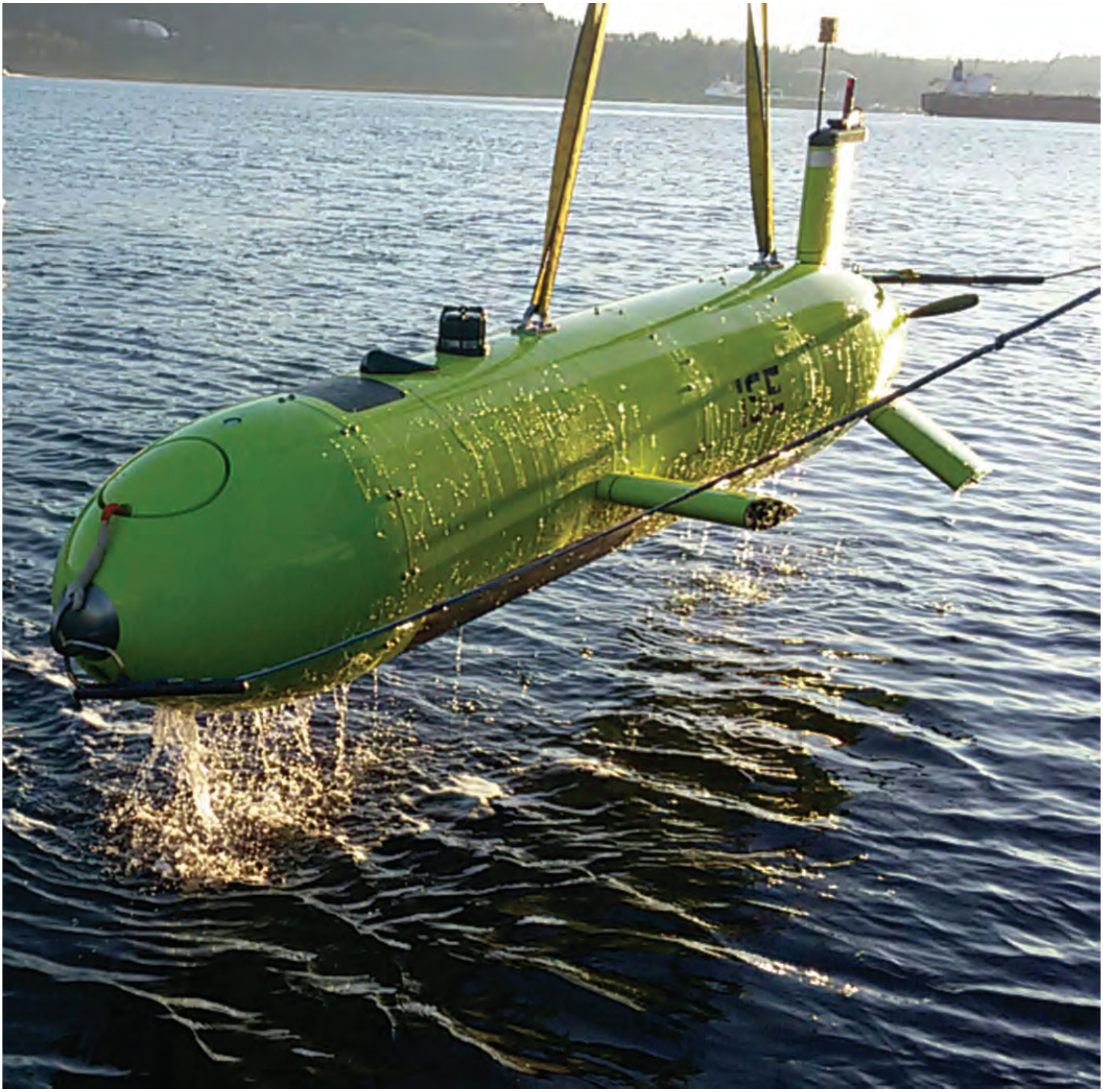


Photo Credit: International Submarine Engineering

lay the communications cable of a Cold War acoustic array on the seabed from a research station on an island to one on an ice-flow. Recently, another ISE AUV made headlines in Australia for taking University of Tasmania researchers on a mission to survey the southern polar ice.

AUV network

"I think the ability to coordinate survey logistics with multiple AUVs is something that has been done," says ISE business-development manager, Phil Reynolds, in possible reference to AMOS's networked AUVs. "Some preliminary operations have taken place. That's a trend we see. The ability to communicate not just acoustically but by other means to surface vessels and satellites."

For ISE's scalable AUVs and battery sections, it might not matter if payloads change from cable hooks and navigational aids to spectral cameras and satellite- or drone launch equipment. For OEMs in general, however, changing payloads — or combinations of multibeam echosounders, side-scan sonars, sub-bottom profilers, synthetic aperture sonars, high-definition cameras, laser systems, and chemical sensors — imply uncertainty in production. Some companies, like France's ECE, appear to have an AUV for every mission: an imaging A18-E; the maneuverable, twin-hull A18-TD for "homeland" surveillance; a man-portable A9-s and about a dozen others. Like its competitors, perhaps, ECE sells the mission: wide-area surveillance; search and rescue, seabed scans mine detection.

Size disruptor

While building a different AUV for every scientific mission may seem pointless, that's not so for the naval market. Missions—or military scenarios—are ever-changing, and so hundreds of AUV types have been built for them.

So, while both the naval and science markets are publicly funded, naval threat pictures are both created and populated by the AUV. Quantities of them have a quality all their own. Then there's the large AUV. They're floating proof that the naval market has moved on from strictly AUV motors to more robust marine thrusters, and the greater involvement of the marine supply chain cannot be too distant. Unmanned large AUVs can launch drones, be partly unmanned and their payloads can be augmented or replaced by a drone and/or a knot of navy SEALs. Like littoral insertions and surveillance ops, new missions in this market are devised all the time.

Both Lockheed Martin and Boeing have recently revealed very-large AUVs, and yet that cable-laying ISE AUV back in 96' was also pretty large. "The size depends on endurance and the length of the operation. That's the main driver. The amount of ballast would have some bearing as well. For the most part, it's endurance. For 24/7 endurance, then you need additional battery power," says Reynolds. ISE would know. Its subsea business is rooted in long-haul military work.

Ordinary disruption

Missions — probable or imagined — are, to be sure, guiding supplier offerings of larger units to the world's navies.

Kongsberg Group's US business, Hydroid Inc. (and Hydroid subsidiary Kongsberg Underwater Technology, Inc.) now offers the remarkable REMUS 6000, its numeric tag a nod its diving depth.

With the software and electronics of the smaller, proven, multi-role REMUS 100, the larger REMUS is sure to impress a U.S. Navy contemplating missions as mind-blowing as patrolling transatlantic cables; knocking out seabed listening posts or hardening vital national infrastructure like harbors and offshore oil platforms. Mission possibilities, especially recce, are as boundless as the imagination.

Yet, despite the financial clout of Kongsberg Maritime and its worldwide researcher ties, the pioneering ISE, with its scalable units, sees itself as a credible rival even on contracts for large, deep-diving AUVs: "Our newest build, a 6000 model will be delivered. We have a customer in mind," Reynolds confides. A host of other suppliers hope to be so effortlessly disruptive. One AUV maker recently interviewed on ***Maritime Reporter TV*** made naval-market inroads with a $10,000 man-portable AUV that can be dropped from airplanes.

Convergence

According to a Douglass-Westwood AUV forecast, military AUV demand will provide the largest market through to 2022. As AUV missions mushroom, military procurement will account for 72 percent of all demand and will grow 10 percent per year. The research sector is seen experiencing limited growth in that time. The complexity and long planning horizons of those research missions is clearly the reason. The fog in the forecast is the increased convergence of "ocean" and "mil". The two markets are just a payload apart. Even the oilfield intervention made possible by the bio-mimicking of snakelike AUV Eelume could turn military (you can just imagine it slithering through submarine netting).

AMOS researchers brought that biomimicking to market. Asked to comment on the statement, "The difference between

war-fighting and oceanographic research is payload," Martinsen had a telling reply: "The statement points to a valid paradox. We can seldom control the application of our research. However, the same paradox is present for the majority of the technology we surround ourselves with. However, being a University, NTNU does not take on research targeted towards warfare and applications intended for armed encounters."

Trend as disruptor

Other research communities of necessity do. Some are part of a European AUV research program called SWARMS.

SWARMS is about "smart networked underwater robots cooperating in meshes", and while it implies the "biomimicry" of bees, it has at least one unusual market in mind: future ocean mining. The disruptive element seems to be the network itself, a way to tie-in ROVs and other vessels.

There's a US Navy swarm program, of course, and it seems to use AI to mimic underwater what the Navy's LOCUST program does with aerial drones. Yes, it's advanced, but Chinese AI guru Kai-Fu Lee, in his book AI Superpowers: China, Silicon Valley and the New World Order, suggest AI disruption might be more widespread than once thought.

For now, should the EU SWARMS program succeed, it could mean the proliferation of networked AUVs employing working together without AI. One thing's for sure, networked and AI-enabled AUVs would make formidable foes for any naval vessel — or a great team for exploring the vast oceans. Both are already disrupting the AUV market.

And then there's AUV docking: "Docking is a trend for the future," Reynolds says. "We're at the early stages. It's a seafloor-based docking system or surface, but dock and upload data and have the battery recharge. Those are the things that would be prudent for an AUV manufacturer to look at maturing."

Martin Ludvigsen AUV scientists.

Photo Credit: Professor Martin Ludvigsen, NTNU AMOS

Whats new in the world of Vehicles

The unmanned underwater vehicle market continues to evolve, as remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs) add characteristics and performance parameters that bring them closer together. Following are recent innovations and case studies of recent operations from some industry leading companies supplying to this space.

Saab Seaeye Leopard & the Electric Evolution

Saab Seaeye's Leopard is an electric underwater vehicles that is helping to advance the technology as an alternative to hydraulic systems. With 11 thrusters and an iCON intelligent control architecture, the 3000m rated Leopard is considered the most powerful electric work vehicle of its compact size in the world. Its ratio of thrust to volume and speed through water brings the power, payload and control stability needed to carry the hefty range of tooling and sensors usually associated with considerably larger systems.

The Leopard, as an electric systems can tolerate higher environmental temperature ranges and it has the power and intelligent control to handle strong currents.

When compared to a 60-ton hydraulic system, the Leopard's 30-ton complete package offers a smaller footprint, faster mobilization time, lower maintenance costs and fewer staff at the worksite. The electric revolution comes as advances in intelligent control, miniaturization and power technology makes systems smaller, smarter, more agile and more powerful.

A key development powering the electric revolution is the introduction of the iCON intelligent control architecture with its infinite building block modularity for task resolution.

It also allows the Leopard to 'think for itself,' leaving the operator free to concentrate on the task at hand while the system maintains a stable work platform when working with heavy tooling in adverse conditions, including strong cross currents.

Remote management is made easier as the Leopard's state of operation and health can be monitored through remote diagnostics to anywhere onshore.

Should the Leopard suffer multiple equipment damage it has a chance of remaining on task, as iCON independently manages each intelligent device on the vehicle to create a state of auto redundancy.

VideoRay: MSS Defender

The VideoRay Mission Specialist Series (MSS) Remotely Operated Vehicles (ROVs) are customizable and flexible underwater vehicle platforms that use a system of interchangeable, modular components. Two configurations are available the Defender and the Pro 5.

The VideoRay Mission Specialist Defender configuration uses seven thrusters when operating to move in any direction and maintain active pitch to hold the vehicle in an upward or downward orientation. The Defender's topside includes integrated control and navigation, which makes the Defender a popular configuration for tough or heavy-duty missions. Since the Defender was fielded over a year ago, it has found broad acceptance in the oilfield, aquaculture and defense industries.

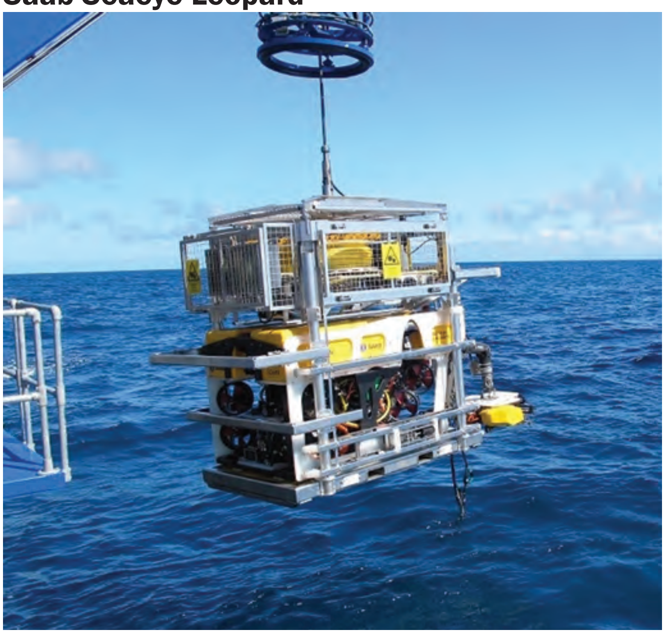
The Mission Specialist VideoRay Pro 5 configuration is designed for speed and efficiency. The three-thruster system is designed to handle missions with size, space, weight, and deployment speed constraints, such as infrastructure inspections beyond the reach of divers, search & recovery, exploring the ocean floor up to 305m, and various others. The Pro 5 builds on the strengths of the Pro 4, with more thrust, longer tether lengths, higher resolution video, and the advantages of the MSS modular systems. The Defender and Pro 5 were used recently in the Galapagos by the Charles Darwin Foundation for seamount exploration and research. A total of five days were spent at sea collecting data in the form of video transects, with VideoRay's modular systems providing seamless integration and operation of a stereo-video system. Footage collected during the mission included: mesophotic soft coral reefs (between 40-60m deep) and deep-sea glass sponge gardens (between 150-180m deep) teeming with interesting fish species. The highlight was the discovery of a macro-algae dominated landscape that is likely a kelp forest on the summits of a seamount.

DOER Marine: Delving Deep in the Pacific

The University of Hawaii's H6500 ROV "Lu'ukai" supported a number of missions in 2018, making over 100 dives in total. DOER Marine built the H6500 system which includes an ROV with TMS that operates on standard .681 oceanographic umbilical. The ROV is equipped with dual manipulator arms, multiple cameras, Cathx lighting, seven 5HP thrusters, a retractable collection drawer, sonar, altimeter, DVL, Phins and additional sensors/instruments. The multiple TMS cameras and lighting provide overhead views of the ROV when working in terrain or around objects on the seabed.

On average, dives ranged from 4000m to 5500m with up to 20 hours of bottom time. During the seven-week Clarion Clipperton Ridge cruise, numerous species were documented and secured in bio boxes using the dual manipulator arms. A fossilized whale skeleton was observed along with the mineral

Saab Seaeye Leopard



Saab Seaeye

VideoRay: MSS Defender

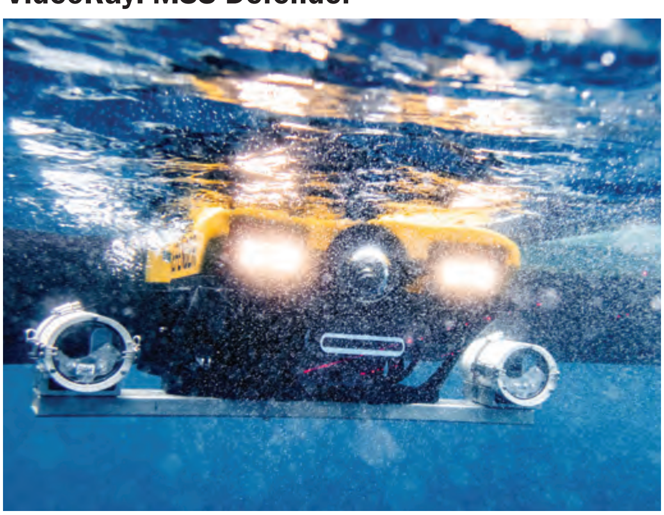


Photo by Joshua Vela Fonseca

DOER Marine

DOER Marine

VideoRay: MSS Defender being depoloyed.

Photo: VideoRay

nodules that are of intense interest to mining companies.

Operations next shifted attention to Station Aloha cabled ocean observatory support. Routine maintenance tasks were performed along with changing some instruments and sensors. The ROV design enables lifting/positioning the instrument packages in addition to performing the more delicate cable manipulation tasks.

The final project of the year saw the deep water system deployed for a special project working in 30m to 400m of water. Despite working in shallow, tropical waters, the system did not experience overheating in the umbilical, even over the course of a 20.5 hour dive. This demonstrated the flexibility and utility of the system, again proving its value as a regional asset in the Pacific.

Blue Robotics

Combining state-of-the-art data analytics with the expandable and customizable technology of Blue Robotics BlueROV2, Abyss Solutions of Sydney, Australia is providing clients with safer, easier and more comprehensive underwater inspections.

With the BlueROV2 Heavy configuration as a platform, Abyss Solutions has integrated a number of off-the-shelf external sensors such as an imaging sonar, USBL, UT Gauge, and High Powered LED strobe lights. These sensors complement their in-house designed UHD camera, the LANTERN EYE, an imaging system that allows them to capture the clearest images underwater. These sensors all work together in conjunction with Blue Robotics open-source software to capture targeted and localized UHD imagery. Abyss's analytics return feature-rich 3D models and uses machine learning algorithms to identify and categorize anomalies in an accurate and efficient manner. Interactive visualization tools enable clients to review the asset and make informed decisions on maintenance and management strategies.

The BlueROV2, along with the Blue Robotics line of enabling components, offers versatility for companies looking to integrate their own systems. End users receive additional support from other Blue Robotics users, as noted by Abyss's Robotics Engineer Jordan Jolly in his praise of the online community: "a large group of users willing to help, give advice, and collaborate on modifications/interesting use-cases for the ROV."

Abyss Solutions inspections span a wide range of markets including Oil and Gas, Shipping, Water infrastructure, and Military. They've completed a diverse mix of inspections, including the Hoover Dam Lake Mead Intakes with LVVWD, mooring chains with EXXONMobil, and work with BAE Systems. We look forward to seeing where Abyss takes the BlueROV2 next.

Forum's new eROV

Forum Subsea Technologies' recently launched XLe Spirit is the first observation-class ROV to use Forum's Integrated Control Engine (ICE) to bring greater functionality commonly only found in larger work-class vehicles. The advanced control electronics pod fitted to all Forum XLe observation class vehicles enables superior connectivity and expansion capabilities when compared with other ROV's on the market. Ethernet interfacing allows for seamless integration with other industry sensors using common IP architecture and ease of remote data transfer.

"As the subsea market continues to recover from a sustained downturn, cost efficiency is high on the agenda for the industry," said Kevin Taylor, VP of Subsea, Forum. "Forum recognized the opportunity to apply our leading software to a more compact vehicle to enhance capabilities and meet the changing demands of the sector.

"By utilizing the same system across all vehicles, pilots only have one interface to learn as the skills are transferrable between the smallest observation vehicle and the largest trenchers. This means training can concentrate on operational tasks opposed to control systems, providing further efficiencies."

The XLe Spirit incorporates a number of features to maximize its stability for use as a sensor platform, including regulated propulsion power, optimized thruster orientation and location, accurate thruster speed control and a wide range of auto-functions for positioning and flying.

The XLe Spirit has just completed a 12-week test program at Forum's test tank in Kirkbymoorside, Yorkshire. It will be sent for sea trials in the first quarter of 2019.

Kongsberg Unveils HUGIN Superior AUV

Unveiled in December, Kongsberg Maritime's new HUGIN SUPERIOR AUV introduces significantly enhanced data, positioning and endurance capabilities that combine to stimulate a step-change in subsea survey operations for commercial, government, and naval users. The HUGIN SUPERIOR also comes with a 30% increase in energy capacity on board, without changing form factor or size. The extra power available can also be used to maintain current levels of endurance while adding more sensors, increasing productive survey time and contributing even more to reduced OPEX.

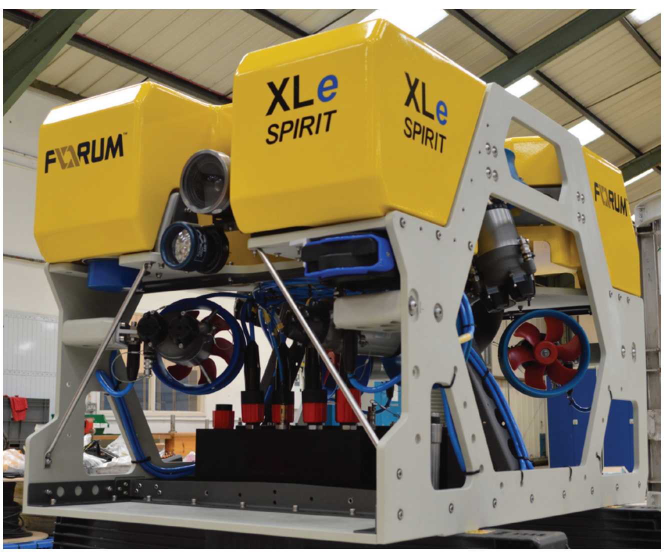
Building on the HUGIN technology platform, KONGSBERG's latest AUV places data quality and its reliable and cost-effective collection front and center. It packages the very latest technologies into one system delivering twice the survey area, including the new HISAS 1032 Dual Receiver Synthetic Aperture Sonar (SAS) which generates approximately 1,000 meters swath at 2.5 knots for SAS imagery, real aperture and SAS bathymetry, with consistent resolution over the entire swath (typically 5x5 cm in mission imagery). HUGIN SUPERIOR also features Kongsberg Maritime's EM2040 mk II multibeam.

Configurable for diverse applications, a class-leading data suite with upgraded SAS processing, sidescan sonar imagery, bathymetry, sub-bottom profiler, camera, laser, magnetometer, turbidity and diverse environmental sensors for i.e., methane and CO_2 measurement, ensure that the new HUGIN is as ready for field development surveys and pipeline inspection as it is for environmental monitoring or wreck searches.

L3 OceanServer's Iver4

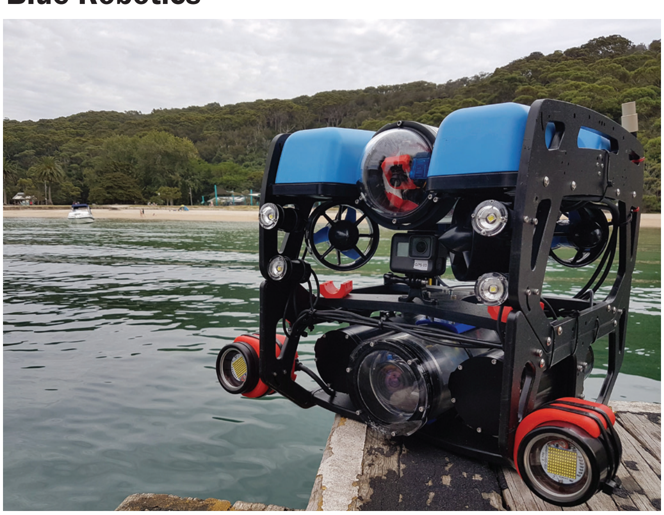
L3 OceanServer's Iver4 is built to complete longer missions with accuracy and ease. The new 300-meter workhorse system features a streamlined design for extended duration capability: 40 nautical mile range with rechargeable NiMH battery system (additional power options available). Constructed of durable titanium and carbon fiber, the Iver4 comes equipped with tracking and safety communications, high accuracy navigation, 200m bottom-lock DVL, precise and repeatable measurements and low drag side scan and bathymetry transducers. Man portable, sealed sections can be easily shipped on common carriers without the concern of hazardous goods shipping and no vacuum required. The Iver4 is part of a family of UUVs that address a wide variety of missions, including commercial and defense applications such as long range survey, multi-domain intelligence, surveillance and reconnaissance (ISR), anti-submarine warfare (ASW), seabed warfare and mine warfare. Specialized missions can be completed using the Iver4's wet-pluggable connectors and swappable payloads, including user-defined payloads. The Iver4 offers a broad range of innovative technologies that enable operators to execute demanding missions with confidence.

Forum's new eROV



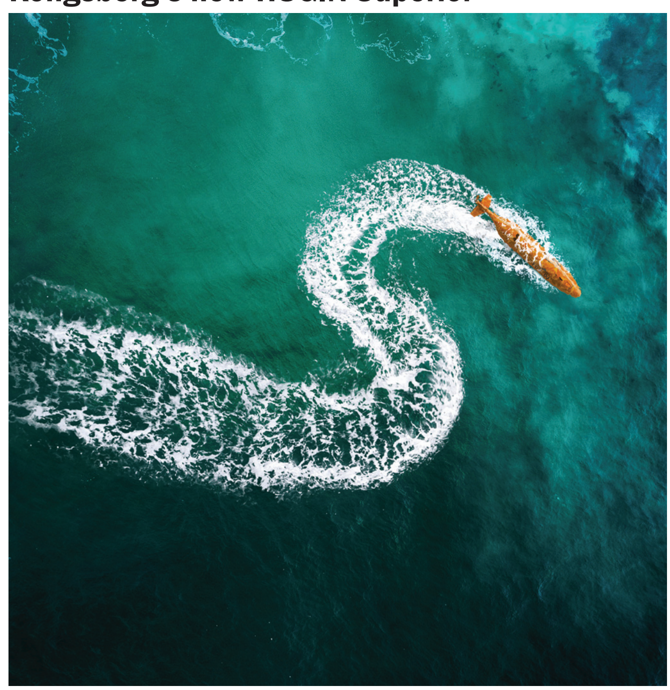
Forum

Blue Robotics



Abyss Solutions

Kongsberg's new HUGIN Superior



Kongsberg

L3 OceanServer's Iver4: A 300m Workhorse

L3 OceanServer

LRAUV

Arctic Oil-Spill-Mapping Robot Put to the Test


U.S. Coast Guard

Onboard the research vessel, the 3-D oil scanning robot LRAUV is ready to test its new configuration.

As commercial shipping and energy activities picks up in the Arctic region, the prospect of accidental oil spills in this pristine environment remain a concern. In response, the U.S. Department of Homeland Security (DHS) is taking the lead – through the U.S. Coast Guard – to develop a subsea robotic system to map and report on spills.

"Because of ice coverage and the tyranny of distance, it is difficult to get resources and assets up in the Arctic in a quick manner," said Kirsten Trego, Executive Director of the Coast Guard's Interagency Coordinating Committee on Oil Pollution Research. "With better real-time data, more effective response strategies can be developed and deployed." To help the Coast Guard map oil spills under ice, the DHS Science and Technology Directorate (S&T) has been working on an underwater robot for the past four years through a DHS Center of Excellence, the Arctic Domain Awareness Center (ADAC) at the University of Alaska Anchorage, in partnership with the Woods Hole Oceanographic Institution (WHOI) and Monterey Bay Aquarium Research Institute.

The result of this research is the Tethys Long Range Autonomic Underwater Vehicle or LRAUV, a helicopter-portable, torpedo-shaped system with oil sensors and navigation capabilities. This robot can provide real-time data for first responders by producing and transmitting 3-D maps of crude oil, diesel, gasoline and kerosene spills. ADAC recently tested this technology in California and plans to do more tests this year and next, including under-ice tests.

Meet LRAUV

Work on LRAUV started in January 2015, the idea born from the stress around the Deep Water Horizon spill in the Gulf of Mexico in 2010, which was measured with "limited sensors and short duration platforms," said S&T Program Manager Theo Gemelas.

To help address the problem of duration, LRAUV – which measures eight feet long, 12 inches wide and weighs 240 pounds – is designed to rove for 15 days and 373 miles without recharging batteries, with the latest prototype able to travel 2-4 feet per second (1-3 miles per hour), communicating with specially installed buoys.

Since there is no cellular coverage in the vast Arctic, the buoys – equipped with Very High Frequency antennas to transmit data via satellites – are a key component to the LRAUV's success. When deployed, the buoys will provide solar or wave power to recharge the robot's batteries, an effective way to keep it charged in such remote conditions.

"This vehicle is the first of its kind. We haven't previously been able to characterize oil spills with an underwater vehicle under solid ice pack," said ADAC Executive Director retired Major General Randy "Church" Kee.

LRAUV Put to the Test

On September 27, 2018, ADAC conducted an open-water test of its LRAUV prototype in Monterey Bay, California, with the goal to characterize an oil spill and transmit data back to shore.

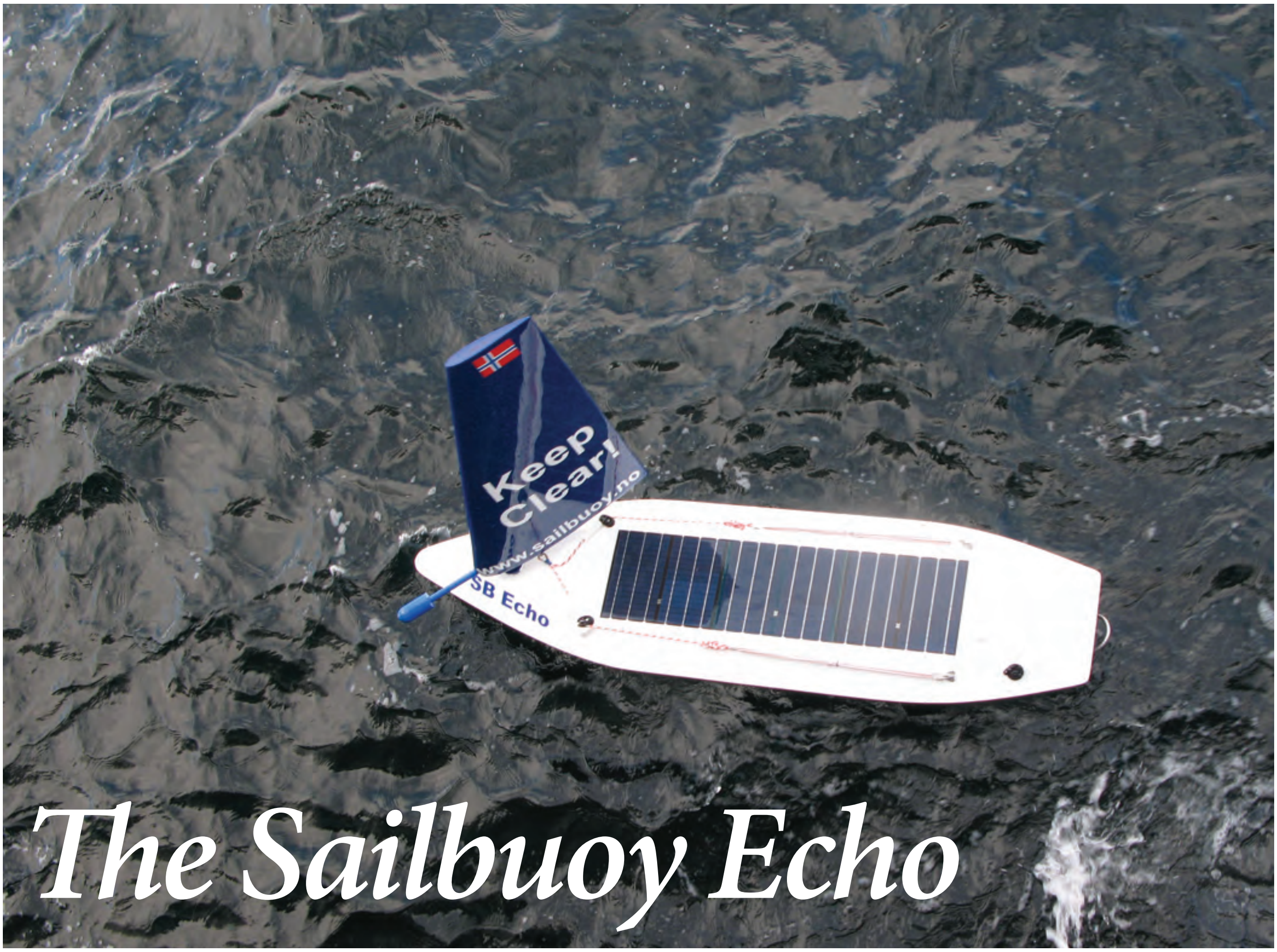
"The researchers showed us how LRAUV works; this was the first test with the oil sensors and data transmission in action," said Trego.

LRAUV was equipped with chemical sensors and simulated an oil spill from a vessel by "leaking" a non-toxic, neon green sea dye into the water. The dye, just like oil, can float in the top 13 feet of the water column, but biodegrades in sunlight in a matter of hours.

"This specific water test was intended to check all the prior work in the newly fabricated vehicle to characterize an oil spill," said Kee.

The robot surfaced every few minutes to transmit and receive data from the control vessel and check its location using cellular connection.

After several hours, LRAUV had scanned successfully the whole area and transmitted the data to shore for analysis.



Credit: Knut Korsbrekke, IMR

The Sailbuoy Echo

The Sailbuoy is an autonomous surface vehicle for long endurance missions. It uses wind for propulsion and solar panels to power the electronics. It is designed and tested for mission lengths of several months in all kind of weather. The Sailbuoy is equipped with sensors depending on user requirements. It is easily handled by two people and doesn't require a crane for deployment or retrieval. Originally made for North Sea conditions it is especially suited for low light and rough weather conditions.

In 2018 a Sailbuoy equipped with an echosounder from Simrad was tested for six months in the Lofoten area (North Norway). Together with a Simrad WBT mini broadband echosounder, the SB Echo had a CT sensor from NBOSI and an Oxygen Optode from Aanderaa. A gimbaled 333 kHz splitbeam broadband transducer was used and the echosounder was run in FM (broadband) mode during this mission. The objective was to evaluate the spatial and vertical distribution of Calanus finmarchicus in the area, and in particular to observe the surface layers of copepods that are inaccessible to hull mounted echosounders on traditional survey vessels. The Sailbuoy is also able to measure these organisms without disturbing the surface layer or influencing the organisms due to e.g. light or noise pollution. The SB Echo travelled a total of 4900 km during the mission and collected 716 GB of echosounder data distributed over more than a million pings. It rendezvoused with several vessels during the mission for data comparison purposes and data download. The conditions varied from low light, freezing temperatures (-10 °C) and storms (+25 m/s) to sunny weather and flat calm. The strong currents in the area did not adversely affect the mission, though they had to be taken in consideration.

The SB Echo reached the mission objectives and provided a wealth of data for scientists to process. Early processing results showed that the Sailbuoy is very well suited for echosounder surveys. In particular, it was demonstrated to be a very low noise platform producing clean echograms. This mission was part of the GLIDER project managed by Akvaplan-Niva AS and funded by ConocoPhillips Skandinavia AS and the Norwegian Research Council.

Sailbuoy Main Particulars	
Displacement	60 kg
Payload	~10 kg
Speed	1-3 knots
Navigable wind speed	3-30 m/s
Navigable wave height	15+ m
Communication	Iridium SBD
Solar Panels	36 W

Robotics & Subsea Discoveries

AUV, ROV Seafloor Mapping Systems used aboard R/V Falkor

Schmidt Ocean Institute's R/V Falkor recently discovered a new hydrothermal vent field, named JaichMatt, in the Souther nPescadero Basin, Gulf of California. The vents were identified using Monterey Bay Aquarium Research Institution's (MBARI) Dorado autonomous underwater vehicle to conduct exploratory seafloor surveys with one meter lateral resolution. Simultaneously, MBARI's new Low Altitude Survey System was used from Schmidt Ocean Institute's ROV SuBastian to map the previously discovered Auka Vent field at centimeter scale resolution using co-located multibeam sonar, scanning laser Lidar, and stereo photography. The biological communities and the geological and geochemical characteristics of these vent fields were then explored and sampled using ROV SuBastian.

Schmidt Ocean Institute

Principal Investigators Drs. Robert Zierenberg from University of California Davis, Victoria Orphan from California Institute of Technology, and David Caress from MBARI, along with scientists from Oregon State University, the Universidad Autónoma de Baja California, the Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), and the Scripps Institution of Oceanography, demonstrated the multi-disciplinary use of submarine robotics while investigating an area of unique geologic activity where submarine volcanism in heavily sedimented basins results in high temperature venting with unusual chemistry and geology.

The nested-scale mapping approach allowed the team to progress from large scale exploratory seafloor coverage to precision targeted sampling on and around the vents.

The detailed maps also allow for quantification of various microbial and animal communities in precise relation to geologic features and areas of focused and diffuse hydrothermal fluid flow.

The new vent field name, JaichMaat, translates to liquid metal in an ancient language of the indigenous people of Mexico surrounding the region, in reference to the reflective hydrothermal fluid and seawater interface that was found ponded along the roof of a large cavern in the hydrothermal mound.

The new vent field consists of multiple hydrothermal calcite mounds up to 25 meters high that were venting fluids at temperatures as high as 287° C.

Groups of animals common in non-hydrothermal settings, including anemones, were also observed for the first time in dense accumulations at the base of the mounds, and many previously unknown species were identified.

The detailed mapping will further allow investigation of the geological and geochemical controls on habitat suitability for different animal and microbial communities. The Pescadero Basin vents harbor unique biology and geology compared to other nearby hydrothermal vent sites.

This system was discovered in 2015 on a MBARI research cruise, and has been visited by scientists only a few times. Research Specialist Jennifer Paduan observed that this exquisite system is different due to the interaction of hydrothermal fluids with sediment, "The hydrothermal structures here are beautiful. The animals and the bacteria that are supported by the vents are different because the chemistry of the fluids is different than the usual sulfide type chimneys."

Hydrothermal vents are an expression of submarine volcanism that is a globally important process and play a vital part in shaping the surface of our planet. "The deep ocean is still one of the least explored frontiers in the solar system," said Principal Investigator Robert Zierenberg.

"Maps of our planet are not as detailed as those of Mercury, Venus, Mars or the moon, because it is hard to map underwater.

This is the frontier." The vents at the Southern Pescadero Basin offer a unique opportunity to compare microbial and animal community compositions between vents with different chemistries and mineral deposits.

Microbes at these vents form the basis of the food web here, and gaining insight into the vent communities helps us understand the whole ecological system.

Pitching a Tent Underwater

Credit: Michael Lombardi

Birns Extreme Cold Hydrostatic Pressure Testing

Credit: Birns

Birns Connectors

Credit: Birns

Pitching a Tent Underwater

A pair of innovators have developed an underwater habitat – a subsea 'base-camp' if you will – that provides a portable deep-sea space for divers, a habitat and dedicated life support system that provides creates a breathable environment. Developed by NYU Meyers professor Winslow Burleson and diving pioneer and explorer Michael Lombardi, the system was awarded a patent in December 2018.

While advances in technology have enabled divers to explore deeper and stay there longer, these excursions require divers to undergo decompression to prevent decompression sickness. Long decompression stops before an ascent can leave divers cold, tired, dehydrated, exposed to the elements and even threatened by predators.

To assist is Lombardi and Burleson's underwater habitat, which is designed to provide a portable respite for divers for decompression and other activities. Divers can enter the tent-like structure, remove their equipment and then engage in a variety of activities, from eating to examining collected specimens to napping or relaxing.

Burleson and Lombardi's underwater habitat offer a number of unique aspects, starting with its portability: the habitat and its anchoring system is portable enough for divers to travel with it in their checked luggage. Another advance is the habitat's modular life support system, which has a replenishable source of oxygen, a scrubber, and a fan to remove carbon dioxide from the environment, continuously cleaning the air in the tent. This unique ability to control the atmospheric composition creates a safe and breathable environment for divers. The habitat was successfully deployed during a test dive off the coast of Rhode Island in late October, conducting the first-ever field deployment of the patented life support system. They will continue to conduct a series of test dives this spring, and will begin to spend longer periods of time underwater, up to 8-12 hours, and possibly overnight, within the next six months.

Birns Extreme Cold Hydrostatic Pressure Testing

At both Underwater Intervention in New Orleans and Oceanology International North America in San Diego the Birns team will be onhand sharing details of cool new marine technology – literally and figuratively. The company recently developed new extreme low temperature, extreme depth testing capabilities, a new system that allows 48 hour+ continuous testing of connectors and cable assemblies at 6km in a controlled 2°C (±1°C) environment. The new cold hydrostatic pressure testing provides automated, programmable multiple pressure cycles with real time data recording of electrical and optical testing, along with digital output of pressure and temperature data. It was initially developed to meet customer requirements for a new BIRNS Millennium 6km-rated hybrid electro-optical pin configuration, the 3O-1F3, which features the Birn's new 1.25mm optical ferrule.

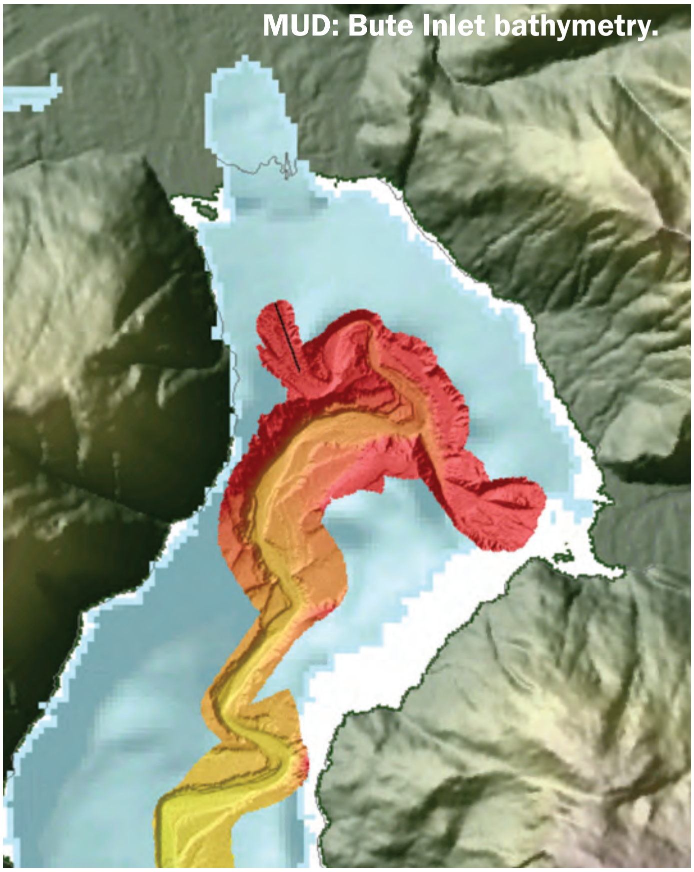


Image: ASL

MUD deployment diagram.

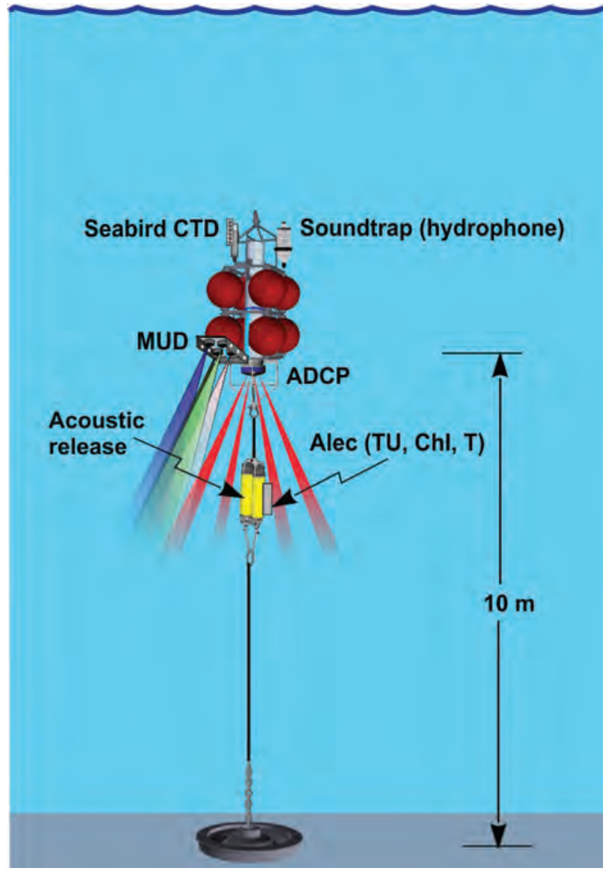


Image: ASL

MUD: Next Gen in Acoustic Backscatter Measurements

A new tool to measure both sediment concentration and sediment size is being built by ASL Environmental Sciences Inc. (ASL). The Multi-frequency Ultrasonic Device (MUD) is based on ASL's successful Acoustic Zooplankton Fish Profiler (AZFP). The MUD and AZFP echosounders can be configured with up to four frequencies ranging from 38 kHz to 2 MHz. The MUD prototype is based on a set of higher frequencies (200 kHz, 769 kHz, 1.2 MHz and 2.0 MHz) that will allow for a broad range of particle size discrimination. While the AZFP is a high gain device for low scattering conditions and the greatest possible range, the MUD echosounder is a lower gain system that is being tuned to work in higher backscatter regimes such as the bottom or high concentrations of suspended sediment. ASL's echosounders are designed for autonomous deployments, with small size and low power draw. In May 2018, Dr. Gwyn Lintern of NRCan, in collaboration with university researchers, deployed a three frequency (200 kHz, 769 kHz, 1250 kHz) MUD in Bute Inlet, one of the principal inlets of the British Columbia coast. This site was selected due to its large number of seasonal turbidity flows. The timing of the deployment coincided with the spring freshet, a time where turbulent suspension of sediments was likely. On May 15 a turbidity flow event was detected by the MUD. All three frequencies clearly recorded the characteristics of the turbidity flow without saturating. These real world data, along with further in-situ and laboratory calibrations will provide a method to develop multifrequency inversion techniques to resolve sediment concentration.

RE2's Dexterous Maritime Manipulation System (DM2S)

Through funding from the Office of Naval Research (ONR), RE2's Dexterous Maritime Manipulation System (DM2S) will provide Navy Explosive Ordnance Disposal (EOD) personnel with the ability to remotely and effectively address Waterborne Improvized Explosive Devices (WBIEDs) with the control, accuracy and speed of a human diver. The system is designed with two identical arms to ensure modularity, simplify development, gain economy of scale, and aid in ease of repair. Each electromechanical manipulator arm consists of six Degrees of Freedom (DoF), and the system's modular joint design allows for the easy addition and removal of joints, making the system highly configurable. The arms, which can be mounted on a variety of ROVs, are neutrally buoyant, allowing the system to remain controllable at designated depths, and only require 24 volts and Ethernet communications to operate.

Arctic FoxTail: Oil Spill Cleanup for the Arctic

A new oil spill response device capable of cleaning up spills in arctic conditions has been launched in an effort to bolster Norway's spill preparedness.

The new device, dubbed Arctic FoxTail, is a winterized version of H. Hen-

exterous Maritime Manipulation System

RE2

Photo: H. Henriksen

Arctic FoxTail on MS Polarsyssel

ASL

Sea Level Variation Study: GPS and Ice Profiling Sonar

riksen's standard Foxtail vertical adhesion band (VAB) skimmer, which filters out oil spills from the seawater using its sorbent mops. The system is capable of salvaging large quantities of oil after a spill, without much unnecessary water.

Tonsberg-based H. Henriksen began to develop the Arctic ready system through the Norwegian Clean Seas Association for Operating Companies (NOFO) and Norwegian Coastal Administration (NCA) Oil Spill Response 2015 program, which invited vendors to develop new commercially avilable technologies to handle oil spill recovery in arctic conditions. H. Henriksen's Arctic FoxTail proposal was accepted, and protype development started in 2016.

The scope of the project was to widen the weather widow in which oil can be taken from the water with skimmers. According to H. Henriksen, the old skimmers are very redundant to the sea state and weather, but their efficiency is reduced in cold weather when ice starts growing on the machines (mainly from sea-spray). The newly launched winterized version features an integrated transfer pump, insulated cover and hydraulic heating system, representing a major redesign of the standard model.

The standard FoxTail operates in -6°C, compared to the new Arctic Foxtail which can operate -21°C under the same sea temperature and wind conditions, the developer said. H. Henriksen said the Arctic FoxTail proved capable of stable and continuous operation in sub-zero arctic conditions during recent testing on board MS Polarsyssel in Longyearbyen, Svalbard.

Sea Level Variation Study: GPS and Ice Profiling Sonar

Dr. David Holland of New York University, in collaboration with Dr. Natalya Gomez at McGill University, is leading an investigation of sea level variations in the Disko Bay region of western Greenland. A shore-based system compares the direct arrival of GPS signals to the signals reflected on the sea surface to obtain sea level. The presence of sea ice and icebergs complicate the measurements. A shore-mounted camera provides information about the surroundings and the presence of sea ice and icebergs when there is daylight. Underwater sonar devices can supplement the camera-based observations and eliminate the dependence on daylight to characterize the ice. An ASL Ice Profiling Sonar (IPS) was chosen to make ice-draft measurements. Two sites located within 150 m of shore in water depths of 20–30 m were selected. One of the sites near Jakobshavn Glacier could not be accessed by a boat so it had to be accessed by a combination of helicopter and a small rubber boat. ASL's engineering team was tasked with designing and building a lightweight mooring system which could be deployed by two people using the small rubber boat. In the summer of 2018, the field team successfully deployed both mooring systems. The team is currently looking forward to the 2019 field season to service the shore-based and mooring-based instruments and recover the data stored on site.

GEBCO Seabed 2030

At the heart of OiA '19 event in San Diego – February 25-27, 2019

Seabed 2030 quickfire presentation and panel discussion to feature among highlights as Oceanology International conference and exhibition celebrates its half-century in San Diego

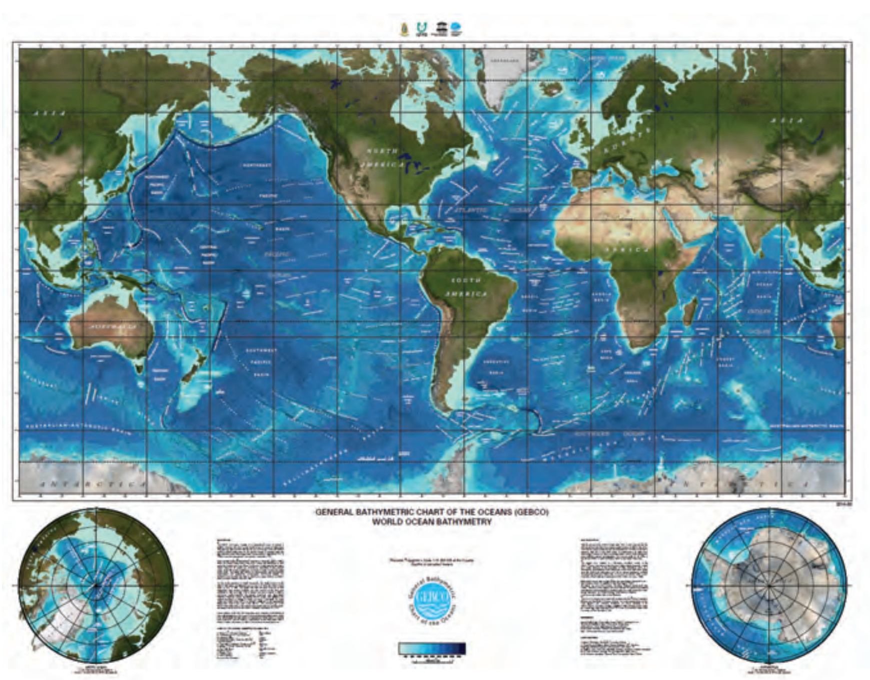
Ocean scientists engaged in the field of bathymetry might feel it is incumbent upon them to issue a dutiful smile when someone asks if they've managed to 'get to the bottom' of their current project. Nevertheless, this trite utterance contains an unwittingly painful and pertinent observation. 'We know more about the surface of Mars than the Earth's ocean floor' has become something of an overused phrase, but that doesn't make it any less accurate – or imperative.

It is precisely this situation which The Nippon Foundation-GEBCO Seabed 2030 Project seeks to address. Launched at the United Nations' Ocean Conference in New York in June 2017, the project's purpose is misleadingly straightforward: to map the entirety of the world's ocean floor by 2030.

The Nippon Foundation has already committed to providing approximately $2 million per year as seed money for Seabed 2030, but those leading the project are aware that a collective effort from the international maritime community will also be necessary if it is to meet its ambitious target. "Mapping the entire ocean floor by 2030 is clearly a significant undertaking," says Acting Director Dr. Graham Allen. "It will require unprecedented collaboration from a range of stakeholders including governments, scientific research institutions, NGOs and the private sector – but I am confident Seabed 2030 will be the catalyst for that coordinated global effort."

The whys and wherefores of this commendable enterprise are involved and numerous, so a lucid explanation of the project's aims, requirements and methodology is essential to bring potential partners and contributors up to speed – and, ideally, get them on board. Consequently, a special Seabed 2030 Quickfire Presentation and Panel Discussion is to be held as a key technical session at the Oceanology International Americas 2019 conference and exhibition (OiA '19) in the San Diego Convention Center on Tuesday, 26 February 2019, 14.30-16.00.

In the half-century since the first Oceanology International was staged



GEBCO Seabed 2030

The GEBCO world maps shows the bathymetry of the world's ocean floor in the form of a shaded relief color map.

GEBCO Seabed 2030

Yohei Sasakawa launches the operational phase of The Nippon Foundation – GEBCO Seabed 2030 project in Tokyo in February 2018.

in Brighton in 1969, this well-respected ocean science forum has expanded to become a must-attend event with a worldwide profile and commensurate influence, now represented with offshoots in new territories – China and the US. OiA '19, the second Oi to be held in San Diego, coincides with the conference and exhibition's 50th anniversary, and event organizers will as such be pulling out all the stops to ensure that delegates have an especially productive and memorable experience.

"Longevity in the world of conferences and expositions is often the exception, not the norm, so the fact that Oceanology International is celebrating its 50th anniversary is most impressive," said David Millar, Government Accounts Director Americas for Fugro and co-chair of the OiA '19 Seabed 2030 presentation and discussion (alongside Rear Admiral Shepard Smith, Director of NOAA's Office of Coast Survey). "Fugro has been associated with Oceanology International for many years. As for myself, it has probably been 17 years since I went to my first Oceanology International, and it's gratifying to see that this long-running conference and exhibition is still providing such value to the maritime community."

Among its myriad other attributes, OiA '19 naturally provides a ready-made forum through which to promote Seabed 2030 as a project of unquestionable long-term consequence, as David Millar explains.

"I see Seabed 2030 as a once-in-a-lifetime opportunity to rally a community around a cause that is critically important to the sustainability of our planet. It represents the unique chance to participate in a global ocean mapping initiative that will provide information and knowledge which truly has the potential to make the world a better place for our children and future generations."

Warming to his theme, Millar continues: "Seabed 2030, coinciding with the United Nations Decade of Ocean Science for Sustainable Development, provides a focus we have not had before. Having spent my entire professional career involved with ocean mapping, the opportunity to now help promote the need, to rally resources and help to get it done, is personally very satisfying."

Following an introduction in which RDML Shepard Smith will provide some background on how NOAA, as a national hydrographic authority, is incorporating Seabed 2030 into its plans and strategies, the floor will then be handed over to six panellists who will each deliver a short presentation elaborating upon various aspects of Seabed 2030, its connection to the UN Decade of Ocean Science for Sustainable Development and the role of industry in both.

The panellists will include Dr Vicki Ferrini, Research Scientist at Columbia University's Lamont-Doherty Earth Observatory and Head of the Atlantic and Indian Ocean Regional Centre of Seabed 2030, who will represent the Seabed 2030 Project Team and provide an overview of the project. "This will be my first Oi event," Dr Ferrini said, "and I'm thrilled to have the opportunity to learn from attendees and make new connections. Mapping the global ocean can only be achieved by working together, at a variety of scales and across different sectors of the maritime community. We need an all-hands-on-deck approach and need to ensure that there are no barriers to participating."

Among the other panellists will be Fugro Geoscientist Dr Kelley Brumley. "Seeing the seafloor in total will change the way we think about aspects as large-scale as plate tectonic reconstructions and ocean circulation, to smaller-scale elements such as plankton migration and fish habitats."

Dr. Brumley is emphatic about the significance of Seabed 2030's coordinated mapping objectives. "Without this project, we would continue our hunt-and-peck methods; potentially harming our oceans in the process."

The presentations will conclude with a moderated Q&A session, and Dr Ferrini is confident of a positive outcome, leading to a wider engagement with the project. "I am filled with optimism. We are transitioning into a new era of bathymetry, and I believe we truly have the potential to change the world. We are in the midst of a technological revolution as we move toward using more autonomy in ocean sciences and in data science."

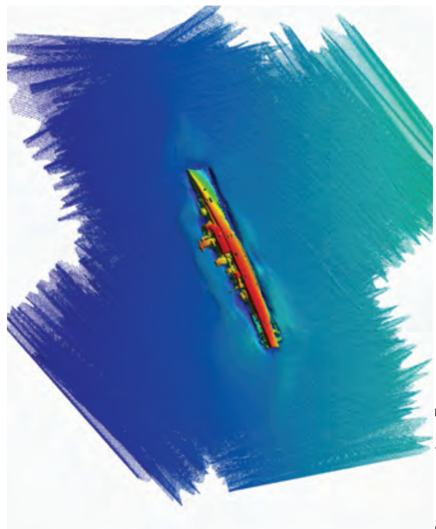


Image courtesy Fugro

Color coded bathymetry showing sunken vessel on seafloor.

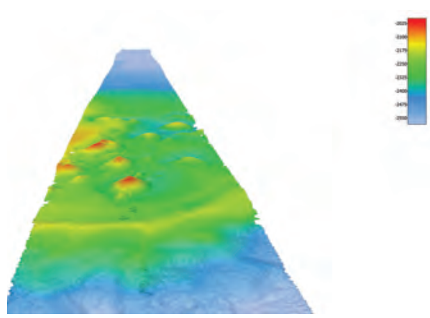


Image courtesy Fugro

Color coded bathymetry of multibeam data contributed by Fugro from a recent transit that shows seamounts on the surrounding seafloor.

"There is a 'bathymetric community' that is passionate and proselytising," adds Dr Brumley. "Fugro has been an early supporter in this regard, advocating on behalf of the Seabed 2030 project and actively contributing bathymetry to the global database. We certainly are not alone in our ability to participate, and there is tremendous potential for organisations to engage in a way that benefits their businesses, agencies and stakeholders, while also doing good for the planet as whole."

In addition to the Seabed 2030 technical track, OiA '19's ample conference schedule will encompass other detailed tracks on topics including Ocean ICT; Unmanned Vehicles, Vessels and Robotics; Observation and Sensing; Marine Pollution and Environmental Stressors; Navigation and Positioning; and Hydrography, Geophysics and Geotechnics. Meanwhile, on Monday, 25 February 2019, the one-day Ocean Futures Forum will draw upon the combined experience and acumen of business heads and senior strategists to examine compelling technological concerns for the future of a sustainable Blue Economy.

This will be followed in turn by another one-day presentation, Catch The Next Wave: Frontiers Of Exploration (Tuesday, 26 February). Throughout the day, speaker pairings of scientists and explorers will discuss the closely intertwined destinies of their respective fields of expertise, illustrating the many ways in which exploration acts as a driver of technological advancement, and vice versa.

As delegates have come to rightly expect, the far-reaching remit of the conference program will be supported by an equivalent ambitiousness on the exhibition floor, with around 200 companies displaying a comprehensive range of technical and strategic breakthroughs to an estimated 2,750 buyers and influencers from across the Americas and further afield. "I extend an open invitation to anyone and everyone who wishes to play a role in shaping the science and technology needs of the Blue Economy," said Jonathan Heastie, OiA '19 Exhibition Director, "and who wishes to share in that exciting journey."

Image courtesy Saab Seaeye

Saab Seaeye Names Lumsden

Saab Seaeye is expanding its business operations with the appointment of Ryan Lumsden as Business Development Manager. He has wide experience in the underwater vehicle market and will join the company's sales and marketing team where he will focus on further growing the company position in the electric work vehicle market. Saab Seaeye's head office is in Fareham on the south coast and Ryan Lumsden will be based in Aberdeen.

Fugro Adds North Sea Clients

Fugro has attracted seven new clients for its IRM services in the U.K. North Sea. Recent work includes significant pipeline and structure inspections for Centrica Storage, Chrysaor, Dana, Petrofac, Premier, Repsol and Spirit Energy. Work scopes also include light repair and maintenance and decommissioning, using Fugro's multi-role vessels and broad in-house environmental, geotechnical and geophysical expertise. Karl Daly, Fugro's European IRM Service Line Director, commented, "In this competitive market, we are extremely pleased that our experienced IRM team,

Image courtesy Fugro

efficient vessels, in-house ROVs and AUVs and bespoke tooling have helped Fugro to secure these contracts. These all enable us to optimize schedules and reporting to clients, and to reduce project time, costs and risks."

Arctic Rays Chooses GTS as West Coast Rep

Arctic Rays LLC, an underwater technology specialist in the design and manufacturing of high-performance lights, cameras and sub-sea equipment, has announced GTS Consulting as the company's west coast representative. The territory for GTS Consulting on behalf of Arctic Rays includes California, Oregon, Washington and British Columbia.

Sensor and AI System for Plymouth Sound

Photo: Shaun Roster Photography

Two Thales unmanned surface vessels pictured entering Plymouth Sound.

M Subs Ltd. has installed what it calls a 'game changing' sensor system with connected artificial intelligence (AI) machine-learning technology around Plymouth Sound as part of the vision to turn the city into a center of excellence in maritime autonomy and unmanned vehicles. Plymouth-based M Subs will operate a secure network of cameras, radars, and other sensors which will provide situational awareness and communications with the unmanned vehicles operating out of the city's harbor. The system will also provide the command & control of unmanned vehicles using the nearby ranges at sea. Data from the network is being collected and analyzed by machine learning programs by M Subs' growing AI team, with the assistance of Thales and a global and corporate partner leading in the field of machine learning and artificial intelligence. The results of this work will finalize development of the computing system at the heart of the maritime AI system to navigate the Mayflower Autonomous Ship across the Atlantic Ocean in celebration of the 400th anniversary of the original Mayflower sailing in 1620.

UTEC Wins India Survey Work

Image courtesy UTEC

UTEC was awarded a subcontract by McDermott International for a series of survey work scopes offshore eastern India. UTEC was contracted to provide surface and subsea positioning services during the installation of subsea flowlines, pipeline end manifolds and terminations, jumpers, risers and umbilicals that form part of the development of a field in water depths to 2100m. Work started in December 2018 and includes personnel and equipment on 3 vessels.

Underwater Custom Cable

NOVACAVI provided a tailor-made underwater hybrid cable solution to meet the Ligurian Cluster for Marine Technologies (DLTM) needs in enhancing marine and coastal environmental monitoring system in the Cinque Terre Marine Protected Area. 12XM473 underwater cable is a hybrid power and multi-protocol transmission cable engineered to handle its tough subsea application and to withstand long-term deployment in saltwater while connecting sea bottom, subsea sensors and buoy.

Photo: NOVACAVI

MTR Marketplace

PRODUCT, PROFESSIONAL, VESSELS, BARGES & REAL ESTATE FOR SALE

Advertiser Index

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

KNOW WHAT'S BELOW

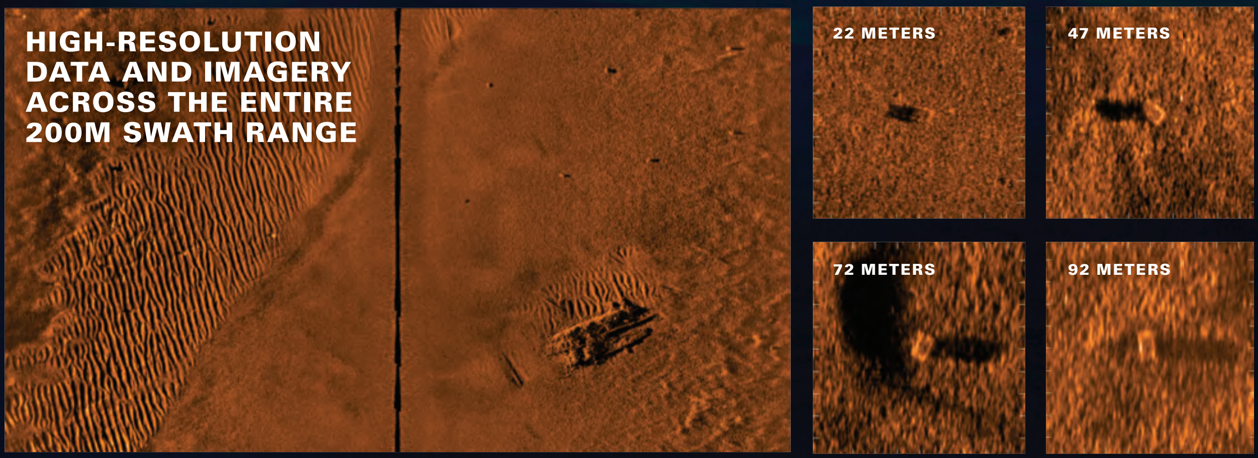
BLUEFIN™-9 UNMANNED UNDERWATER VEHICLE (UUV)

MOST POWERFUL SENSOR PACKAGE IN A TWO-MAN PORTABLE UUV

SIDE SCAN SONAR WITH FULL SWATH BATHYMETRY

HD MACHINE VISION CAMERA • FLUOROMETRY • TURBIDITY

SOUND VELOCITY SENSOR + TEMPERATURE + PRESSURE



LEARN MORE AT WWW.GDMISSIONSYSTEMS.COM/BLUEFIN-9

GENERAL DYNAMICS
Mission Systems

BLUEFIN
ROBOTICS