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Editorial



Courtesy XPRIZE

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T rue innovation has been the hallmark of the MTR100 since we launched it in 2006, and it remains at the core today in our presentation of the 12th Annual MTR100. This year we saw another record number of applicants from around the globe for inclusion in our annual innovation showcase. This year's MTR100 features technologies from 13 countries and four continents, with the predictable lion's share coming from North America and Europe. This year we added a slight twist to the traditional presentation, as our editors and contributors collectively identified and selected 17 "Technology Disruptors" for feature focus, starting on page 30. Compiling the 100 is an annual right of attrition for the editorial staff; to put it simply it is a lot of work. But I've always found it informative and instructive, as invariably I 'meet' new people, companies and technologies for the first time, and I follow with interest the companies that have evolved from the garage to the industrial park.

On the Cover:

Though the feature story on the Shell Ocean Discovery XPRIZE won't publish until the September 2017 edition of *Marine Technology Reporter*, I could not resist this image — one of the competing team's early drawings of its high speed, high resolution mapping device — as to me it embodies the spirit of innovation that is the MTR100, that is the global subsea sector. Look for the feature from **Dr. Jyotika I. Virmani**, Senior Director, Planet & Environment, XPRIZE, in next month's edition.



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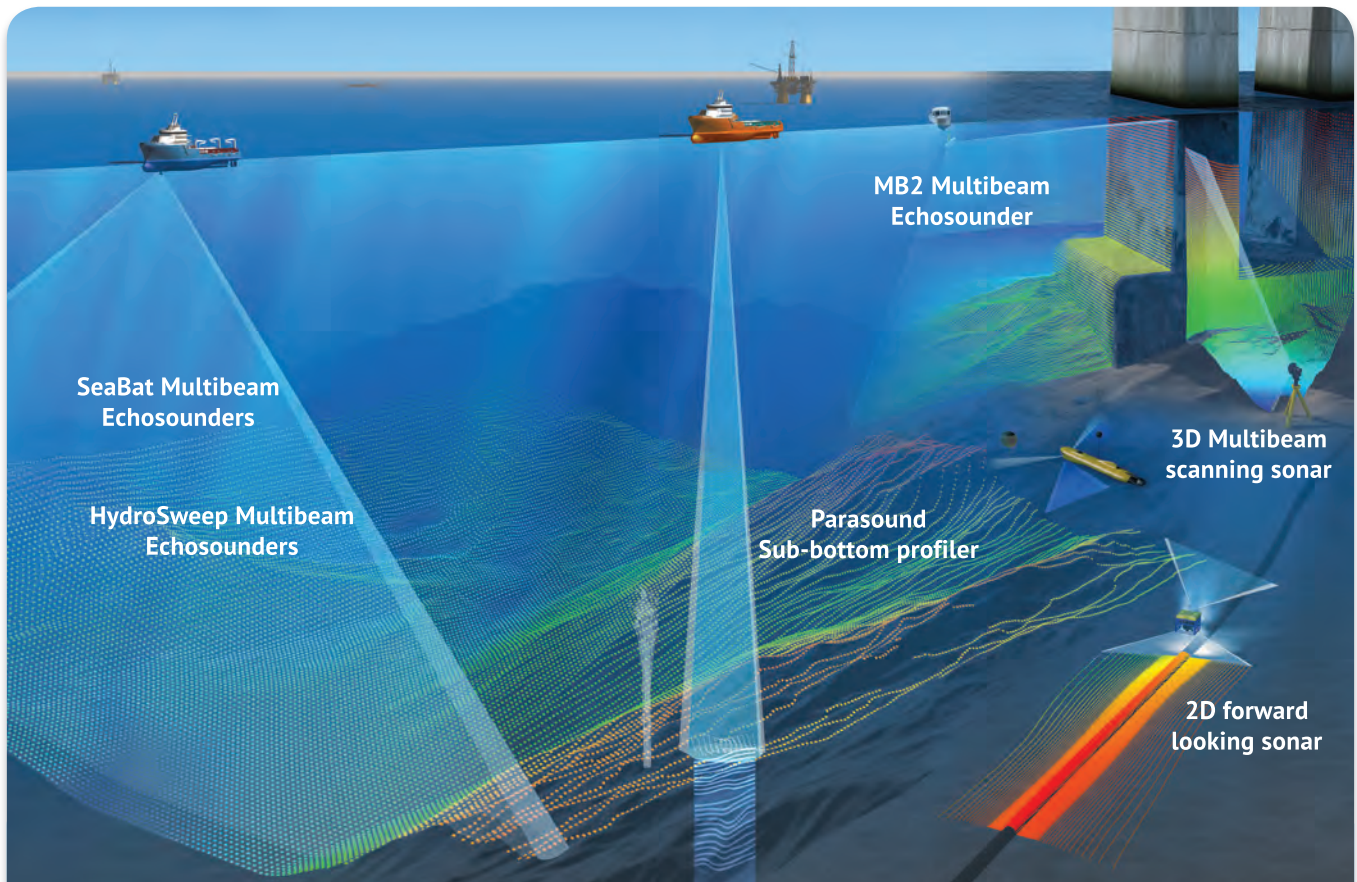
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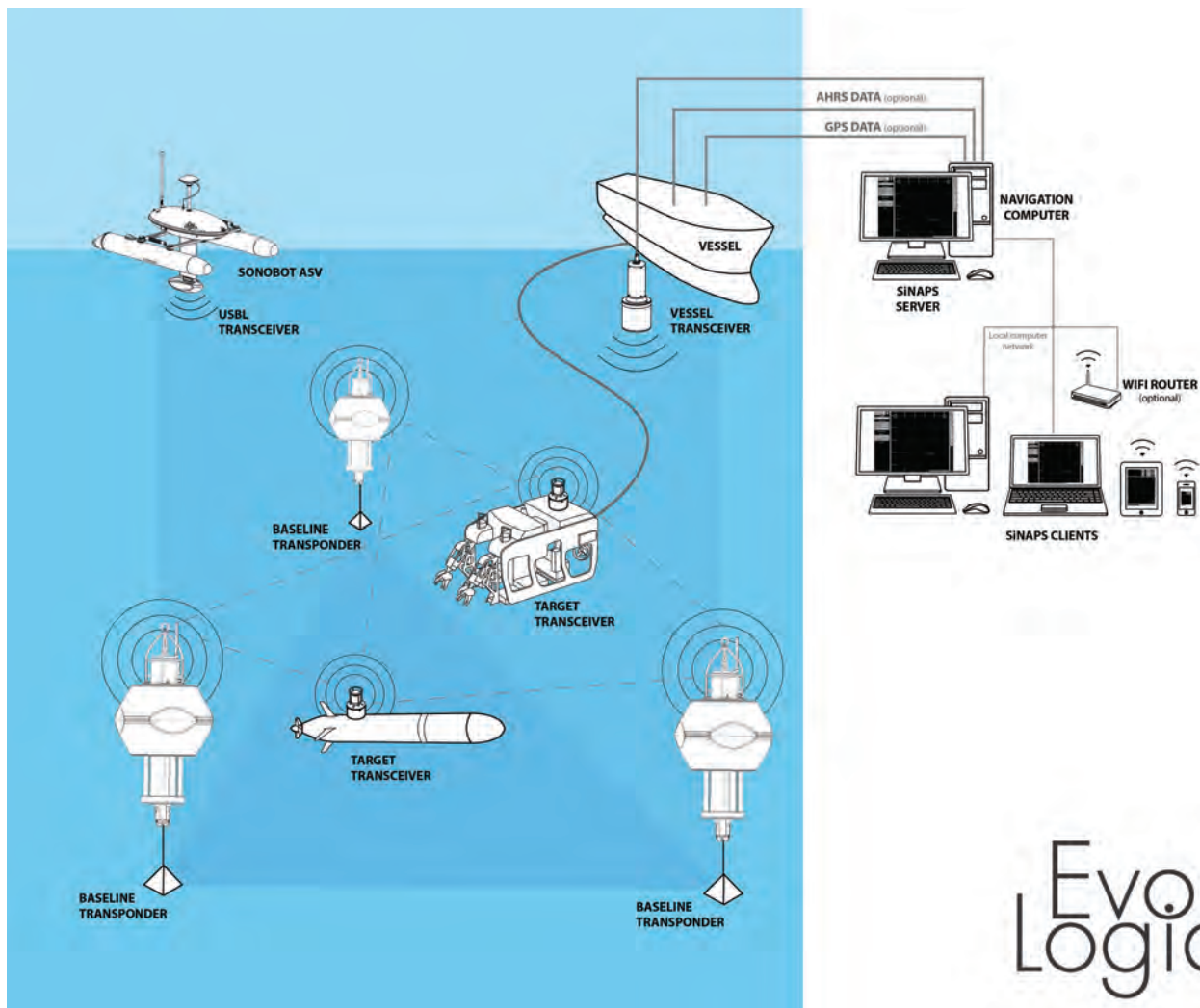
EvoLogics GmbH

Berlin, Germany • <https://evologics.de>

EvoLogics GmbH designs and manufactures underwater information and communication systems based on bionic concepts, combining cutting edge engineering with the best ideas found in nature. The advanced product features have become enabling technologies for deep water exploration and production. It was founded in 2000 by a group of leading international scientists and R&D experts aimed to develop innovative key technologies for the maritime and offshore industries through interdisciplinary cooperation between engineering and life sciences. EvoLogics' products offer highly reliable, flexible and cost-effective solutions for multiple underwater communication, positioning, navigation and monitoring applications. EvoLogics' developments are based on the patented S2C (Sweep Spread Carrier) technology - the reliable acoustic telemetry that provides an independent bidirectional data link along with positioning, broadcasting and networking

capabilities. S2C devices can simultaneously facilitate telemetry and navigation of unmanned underwater vehicles. They enable retrieving information from various sensors and allow to control complex processes by seamlessly combining communication with highly accurate positioning.

Moreover, EvoLogics caters to the needs of scientists, developers and commercial customers with a series of underwater acoustic devices and software tools that offer an open development and testing framework, providing endless opportunities for new implementations. S2C systems have been carefully designed for operations in harsh underwater environments and enhanced with special algorithms for signal processing and data management. The company's extensive experience with sensor integration allows it to provide customers with turn-key solutions ranging from initial deployment up to recovering the equipment.



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Milford, NH, USA
<http://www.airmar.com>

Located in Milford, NH, AIRMAR has the capability of bringing innovative products from prototype to production. It is full-service in the design, engineering and manufacturing of ultrasonic transducers with over 30 years of successful OEM partnerships. AIRMAR employs more than 300 people worldwide and is dedicated to producing a diverse line of marine products to satisfy the acoustic sensing requirements of our customers. Its broadband transducers are supplied as original equipment with many survey echo sounder systems from industry-leading manufacturers.

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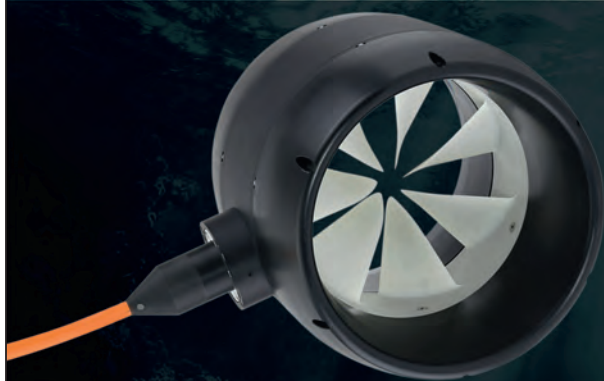
With more than 150 different piezoceramic element and array options, AIRMAR can customize a transducer for nearly any application.

Blue Robotics Inc.

Torrance, CA, USA
<http://www.bluerobotics.com>

In 2014, the idea for Blue Robotics grew out of its own subsea component needs while endeavoring to make a solar powered surfboard to cross the Pacific. Its first product, the T100 Thruster, launched that year through a Kickstarter campaign and sparked its mission to design low-cost, high-quality components to make marine robotics more affordable and accessible. Since then, it has grown and its offering includes thrusters, watertight enclosures, buoyancy foam, subsea cables, cable penetrators, lights, sensors, batteries, control system electronics, and its flagship product, the BlueROV2. Blue Robotics' components

NEW class of ROV Propulsion

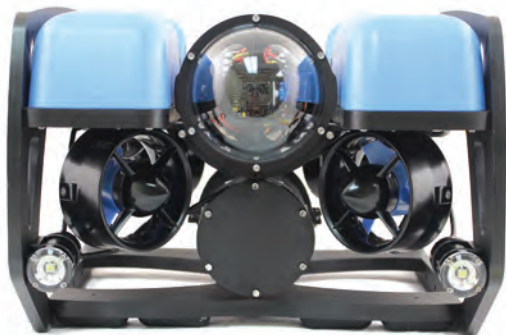


Powerful and silent subsea thrusters from Copenhagen Subsea A/S have been developed with reliability as the highest design priority.

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

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are used for research, academic projects, prototype development and commercial OEM integration around the world. With new products released on a monthly basis, its product line will continue to expand and support the needs of the marine robotics and subsea industries. The BlueROV2 has been on the market for about one year, and over 400 units are

now in use in a wide range of applications from aquaculture to tank inspection to marine biology to archeology.

Blue Robotics' patent-pending thruster design is its most important technology. It uses a unique brushless motor design that is compact, inherently pressure tolerant, and, the company claims, significantly less expensive than comparable

thrusters on the market. Of particular note in the last year is the development and advancement of its ArduSub subsea vehicle control software, which is designed around the open-source ArduPilot project, bringing in advanced sensor and navigation features. Recently, we have integrated the system with acoustic positioning devices to provide a moving-map display of ROV position and autonomous position hold and waypoint navigation. New in 2017 is the Blue Robotics "Crushinator," a pressure test vessel with 45.7 cm (18-in.) inner diameter and 76.2 cm (30-in.) inside length. The vessel can simulate depths of up to 1,015 meters (3,330 ft) and has electrical cable penetrations and an internal live camera view to monitor testing.

Valeport Ltd

Totnes, Devon, U.K. • <http://www.valeport.co.uk/>

Valeport is an independent family owned business based in the UK which designs and manufactures underwater measuring equipment. Valeport has supplied the subsea sector since it was established in 1969 and has a customer base that includes: environmental, research, defense, oil and gas, renewable energy, construction, port/harbor, dredging and civil engineering sectors. Its products include sound velocity probes, current flow meters, wave recorders, tide gauges, fluorometers, CTDs, multi-parameter CTDs, altimeters, depth sensors/bathypack and GPS echo sounders. Valeport exports around 80% directly and at least half of the remainder is sold to UK offices of multinational companies, or as OEM to other British exporting companies, so approaching 90% of production ends up overseas. Valeport is currently observing a buoyant market, particularly in the hydrographic survey and ports and harbor area, where sales of tide gauges, for example, are up by 22%. Valeport sees the oil and gas survey business is showing a gradual resurgence with the Midas SVX2, miniIPS and VA500 Altimeter gaining much favor with contractors as work levels increase.

Valeport has been at the forefront of sound velocity technology since establishing its Digital Time of Flight technology 10 years ago. The latest SVP, SWiFT (pictured), delivers sound velocity profiles providing survey grade sensor technology with the convenience of Bluetooth technology and rechargeable batteries. A new Android app was launched in 2017. Earlier this year Valeport showed a new sensor designed for the dredging community. dredgeMATE combines the power of SWiFT SVP (CTD) technology with a turbidity sensor to



Valeport

create a useful profiler for surveys requiring CTD and turbidity. Valeport is introducing key revisions to the rapidSV and rapidCTD, the probe series that allows data profiling while a vessel is underway; popular with users of the Teledyne rapid-CAST winch deployment systems. A rechargeable battery will deliver extended deployment times; inclusion of GPS will offer the benefits of geo-location of files; and dual Bluetooth will provide enhanced comms for easy data download and allowing a surveyor to conduct SV profiles on command. Valeport has supplied more than 1000 CTD sensors to Sea Mammal Research Unit for use in tags. The design was modified to include a fluorometer to produce a CTF sensor maintaining the small footprint to continue tag integration. The new sensor will help SMRU obtain oceanographic data sets.



BluHaptics

Seattle, WA USA

<http://www.bluhaptics.com>

BluHaptics is developing software that seeks to transition subsea robotics from manual to augmented and automated control. It leverages parallel processing,

machine learning and force feedback to provide safety and efficiency previously not possible with analog/standard control. Its software is designed to make manipulators and ROVs more intuitive and easy to operate, reducing cognitive stress on pilots and while providing a more intuitive and adaptive interface for

pilots.

BluHaptics was started in 2013 with the mission of helping the U.S. Navy achieve enough safety and precision with ROVs to help clean up unexploded ordnance and munitions. The company was spun out of the UW Applied Physics Lab and has grown to nine employ-

ees. BluHaptics has won several grants from multiple agencies, including National Science Foundation, DOD and NASA.

The company is currently developing software for NASA to support robotic operations on the ISS, Lunar and Mars Programs. BluHaptics first software provides a plug and play game pad control system for the Schilling T-4 manipulator. There are several assistive features that provide distinct advantages over the legacy controller, including tool offsets, locking on a plane etc. Future versions of the software will be available on other arms, and will include real time mapping, sensor fusion and machine learning.

BluHaptics has signed a major distribution deal with J2 Subsea for their DEXOS manipulator control software.

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Step inside Sonardyne's global headquarters, 40 miles southwest of London, and any preconceived ideas you may have about the organization and what it does will be quickly dispelled. Acoustics remains a very large part of what this privately-owned subsea technology company does – it's in the DNA. So you'll see plenty of products *MTR* readers will be familiar with such as their popular range of USBL and LBL acoustic transponders and transceivers. However sitting alongside them on the production line these days will be DVLs and INS instruments for navigating ROVs and AUVs, intruder detection sonars for harbor protection duties, high-speed underwater modems for seabed landers and OEM products for third-party integration. So how has this been achieved? For the last decade, Sonardyne has continually invested in developing, expanding, diversifying and transforming its capabilities and methods of working in system engineering, product design and custom solution delivery. No part of the business has been left untouched by this process, from how users' requirements are captured to through-life project management, materials control and custom manufacture. Sonardyne's people share thousands of years of engineering and manufacturing experience between them, including knowledge of what's been done in the past, what's worked and, crucially, what hasn't. There are not many elements of the subsea design puzzle that

haven't been encountered at some point in the company's 45 year history.

From shallow to deep, Sonardyne's Long BaseLine and Ultra-Short BaseLine acoustic positioning systems continue to set the benchmark for performance and reliability. 6G, the company's sixth generation hardware platform, provides robust performance, ease of use, extended functionality, equipment flexibility and compatibility with aided inertial technologies. With a track record spanning 10 years, Sonardyne's Lodestar gyrocompass and SPRINT inertial navigation system range has evolved into its 3rd generation to meet the needs of any subsea application with a smaller housing, and a new range of performance levels. When combined with the company's Syrinx DVL, Lodestar and SPRINT provide unprecedented levels of performance and a single offering for ROV guidance and survey. 6G acoustic and BlueComm wireless optical communication systems can be fitted to USVs and used for harvesting large amounts of stored data from subsea sensors or even the transmission of high definition imagery and real-time video. Sonardyne's sonar imaging technologies are deployed to protect waterside facilities from subsea threats, gather high resolution side-scan imagery for site surveys, keep watch for hydrocarbon and CO2 leaks and aid ship navigation by detecting uncharted obstacles.



Sonardyne

DeepWater Buoyancy

Biddeford, ME, USA

<http://DeepWaterBuoyancy.com>

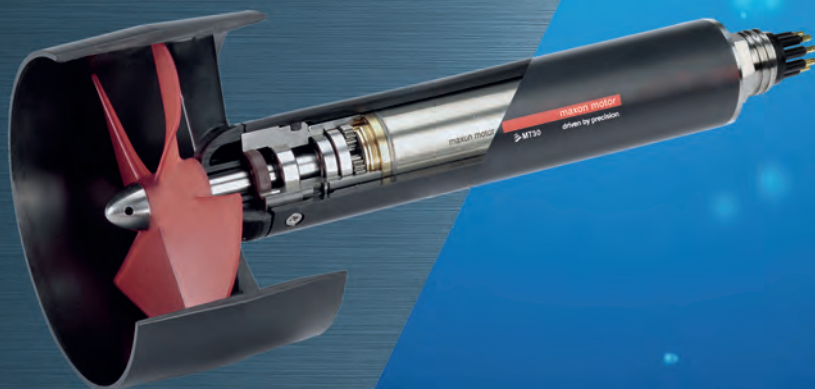
DeepWater Buoyancy Inc. reports that it is the world's largest producer of subsea buoyancy products for the oceanographic industry and has a vast product line of buoyancy solutions for offshore oil and gas, energy and technology companies. This product portfolio has been built over the course of 35 years serving these industries. Though products for shallow water applications are offered, the company specializes in deepwater, providing solutions to depths of 6,000 meters and beyond. DeepWater Buoyancy's headquarters and manufacturing operations are located in New England, the birthplace of syntactic foam. New England is also where David Cook formed Flotation Technologies (Flotec). Incorporated in 1979, Flotec grew into a recognized world leader in the manu-



Photo courtesy of Joe Talbert, University of Washington

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facture of deepwater buoyancy products that included ADCP Buoys, distributed buoyancy modules and drilling riser buoyancy. Flotec was purchased in 2008 by a subsea equipment manufacturer. In 2013, DeepWater Buoyancy acquired the rights and designs for the legacy Flotec material technology and products when its parent company was in the process of closing the New England facility. Since then, DeepWater Buoyancy has been producing, improving and growing the Flotec product line, which has been the industry standard for decades. DeepWater Buoyancy also stocks parts for these legacy products and provides design and application assistance.

At the heart of the DeepWater Buoyancy product line are the subsurface ADCP buoys. These buoys were originally developed for Teledyne RD Instruments' ADCPs. Consisting primarily of

both spherical and elliptical buoys, the product line also includes the unique StableMoor Mooring Buoys. These torpedo-shaped buoys are engineered to house ADCPs and other sensors for high current data collection applications. By design, the StableMoor reduces drag and increases mooring stability in extreme flow regimes, thereby producing superior data sets. However, DeepWater Buoyancy's product line goes well beyond ADCP buoys. In the oceanographic market there are bottom mounts, instrument collars, and cable floats. For offshore oil and gas, there are installation blocks, modular buoys, deepwater marker floats and ROV buoyancy. In addition to DeepTec syntactic foam products and custom-engineered components, there are also polyurethane and fabricated metal products for use subsea.

InterOcean Systems

San Diego, CA, USA

<http://www.interoceansystems.com>

Established in 1945, InterOcean Systems LLC has designed and manufactured high performance oceanographic equipment for more than 70 years. It provides specialized platform mooring release systems, cable handling systems for deployment and recovery of critical sensors and equipment in the offshore environment, and pollution detection and control devices for reducing oil spills in the environment. In addition, InterOcean Systems also offers specialized design, engineering and production for unique applications. In 2016, the company was acquired by the ownership of Delmar Systems, Inc. Delmar, headquartered in Broussard, La., with technical services based in Houston, ,

Silicon Sensing Systems

Plymouth, Devon, U.K. • <http://www.silconsensing.com>

With a heritage dating back more than 100 years, Silicon Sensing Systems and its predecessor companies have a unique record in delivering gyroscope systems to the marine industry. Formed in 1910, Sperry Marine was set up to provide practical navigation and stabilization systems based on the newly emerging gyroscope technology. Spinning wheel gyros were to dominate the market for the next 50-plus years until the emergence of expensive laser and fiber-optic gyros with their enhanced reliability due to their solid-state non-rotating design. With Sperry Marine being subsumed into British Aerospace, Silicon Sensing Systems was formed in 1998 as a result of BAE Systems and

Sumitomo cooperating to develop and produce the next generation of solid-state gyroscopes, based on a silicon MEMS construction. Silicon Sensing Systems flourished, to enjoy an unrivalled reputation for the production of low-cost highly reliable gyros. It led the entry into the consumer car market, producing up to 4M devices per year – and more than 30 million to date. Silicon Sensing Systems Ltd is based in Plymouth, in the southwest of the U.K. The company is now jointly owned by UTC Aerospace Systems, co-located in Plymouth, and Sumitomo Precision Products Amagasaki, Japan. Both companies bring equal strength to the joint venture – inertial



expertise from the U.K./U.S. side, and silicon MEMS fabrication from Japan.

The patented construction of its silicon MEMS gyros – based on a vibrating ring – makes the Silicon Sensing Systems gyros highly resistant to shock and vibration, greatly increasing the reliability and quality of its inertial portfolio. An in-house MEMS foundry has manufactured all of the core gyro technology since the birth of the joint venture. Among its unique fabrication equipment is a deep reactive-ion etching capability, developed in-house in Japan. In recent years, Silicon Sensing has also chosen to develop and produce

a range of sophisticated accelerometers to augment its total inertial capability. Most recently, Silicon Sensing Systems has leveraged the inherent capability of its MEMS devices to create a new range of high performance gyros and inertial systems.

Sensitive enough to detect earth rotation rate, these devices enable a North-seeking capability to be offered to the market – offering performance equivalent to fiber-optic systems but at a greatly reduced price. Specific new products now on offer include, CRS39 and CRH02 gyros (with performance better than 0.1deg/hr bias instability), plus DMU11 and DMU30 inertial measurement units.

has a 49-year history of providing mooring and subsea services to the offshore industry in some of the world's most challenging offshore environments.

InterOcean System's Slick Sleuth uses state-of-the-art technology for the detection and alarm of oil spills in the environment. Slick Sleuth is installed at high-risk locations and instantly warns users of the presence of oil slicks via audible/visual alarm system, data output for client integration, or remote cloud-based mobile application. The InterOcean Rig Anchor Release (RAR) is another example of InterOcean high technology products at work in critical applications, a system of choice for rapid disconnect of large offshore platforms such as drilling rigs.



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Since 2014, Shark Marine has supplied equipment for navigation and diver transport to assist in NASA's Extreme Environment Missions Operations (NEEMO) projects, which send groups of astronauts, engineers and scientists to live in the undersea research station Aquarius, owned and operated by Florida International University, for up to three weeks at a time.

On June 18, 2017, four aquanauts and two habitat technicians descended to the bottom of the Atlantic Ocean almost 6 km off the Florida Keys for NEEMO 22, a 10-day analog mission with objectives similar to that of the exploration of Mars. The mission allowed the aquanauts to live and work in an inhospitable environment where they conduct simulated spacewalks (EVA), to collect and perform scientific exploration and to test tools and procedures that could be used in future space missions. For the recently completed NEEMO 22, Shark Marine provided its dive tablet with DNS for crew navigation and its SubNET underwater communication system to provide navigation data from the Aquanauts back to the Aquarius habitat and then back to the Mission Control Center (MCC) on shore. In addition, to provide robotic assistance for the project, Shark Marine's Barracuda remotely operated vehicle (ROV) has been modified with added wheels and up trailers for toting scientific equipment.



Shark Marine



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www.qps.nl / www.qps-us.com

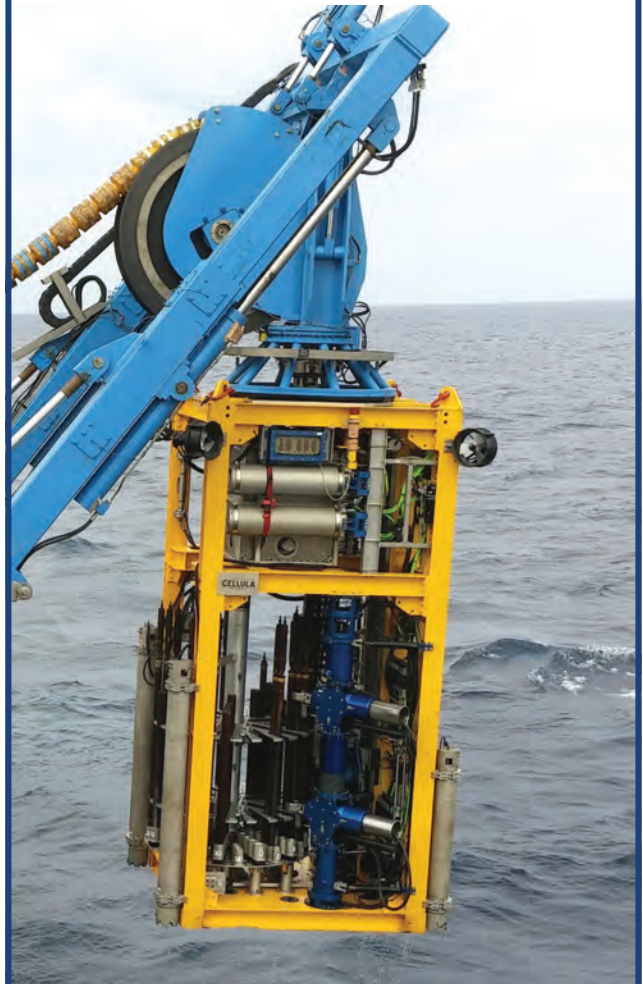
QPS has, since 1986, been headquartered in The Netherlands, and is an independent software company, now with subsidiary offices in the U.S., Canada and U.K. In 2011 QPS merged with IVS3D so uniting QPS QINSy with QPS Fledermaus. In 2012 QPS became a member of the SAAB (Sweden) group of companies (Security and Defense Solutions).

Quality Positioning Services (QPS) makes software for collection, post processing and visualization of maritime geomatic data. Its products QINSy, Qimera and Fledermaus partner third party products, to solve problems and gain efficiencies for maritime related survey business.

Qastor is an Electronic Chart Software (ECS) that enables navigation, piloting and precise docking, as well as several other applications such as oil and gas FPSO/SPM mooring, patrol vessel and tugboat operations.

QINSy is a software suite used for various types of maritime geomatic surveys, ranging from simple single beam surveys up to the very complex offshore construction works. Qimera is an easy to use yet most powerful sonar data processing application. Built using core QPS technologies, As well as QINSy projects, Qimera supports the major raw sonar file formats and by working with the Dynamic Workflow it revolutionizes the way data is handled and the operator experience when processing hydrographic data. Commercial, academic and government clients worldwide use Fledermaus to interact in 4D with geographical datasets. This provides our clients with added value in data processing efficiency, quality control accuracy, data analysis completeness and project integration that promotes clear communication.

www.marinetechologynews.com



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ENGINEERING SOLUTIONS, INTELLIGENT SYSTEMS

Ocean Works International

Burnaby, BC, Canada • <http://www.oceanworks.com> • **Turnover: \$20 million**

OceanWorks International has consistently achieved a leadership role developing and servicing three markets with subsea technology design, manufacture and servicing for over 30 years. The strategic alignment for the organization is aimed to meet and exceed the needs of first response and deeper subsea intervention, diving technology and the complex analysis and testing involved in those markets. OceanWorks is a globally recognized developer and manufacturer of both manned and unmanned subsea systems.

The OceanWorks customer base in sciences and environmental exist specifically in global existing cabled observatories and prospective customers in planned observatories. Other potential areas reside within an alignment to government and academically supported organizations focused on technological achievements in hydrographic monitoring, deep ocean depth communication and data storage systems and long range and long term monitoring systems.

For the military market, OceanWorks offers a full range of Atmospheric Diving System and Submarine Rescue System hardware for both commercial and military applications. Since the company's inception in 1986, OceanWorks has executed more than 70 projects to submarine rescue and submarine systems.

For its oil and gas customers, OceanWorks provides customized solutions to create, develop, maintain and enhance specific oil and gas requirements and challenges. Its oil and gas offerings include; power distribution, control and subsea modules. Enhanced Launch and Recovery solutions. Subsea Systems and continue Subsea support to ensure greater reliability and availability of installed equipment including continuous real-time remote monitoring of facilities and equipment.

SMD

Newcastle upon Tyne, Tyne and Wear, U.K. • <http://www.smd.co.uk>

SMD has established itself as a leading engineering and manufacturing company specializing in remotely operated equipment for hazardous environments. The business has continued to grow an international footprint from its domestic market origins in the North Sea oil and gas and telecoms sectors.

As the subsea group of CRRC Times Electric, SMD is an advanced global supplier of subsea remotely operated and autonomous power and control solutions. This includes specialist trenching equipment such as ploughs, trenchers and tractors and largest range of work class ROVs. SMD also offers bespoke innovative solutions, most recently producing the world's first three deep sea mining machines for Nautilus Minerals Inc. SMD Services support clients through the full operational lifecycle of their assets. Offering a dedicated offshore team, 24/7 support, intelligent spares support, asset management, OEM training, a growing RMU service as well as a state of the art synthetic environment. SMD supply an

innovative range of remotely operated remote intervention equipment, a range of associated deck and handling equipment, control systems and the Curvetech range of ROV components. End solutions vary from one-off bespoke engineering systems to a standard range of work class ROVs. SMD's customers operate equipment in hazardous environments from the deep sea to radioactive buildings, and therefore value the fact that it is robust, reliable and easily maintained. The equipment is of diverse size and complexity, ranging from 250 metric ton tracked mining machines to two-metric-ton free-flying ROVs. SMD have delivered a number of world firsts including the largest free flying techer, most powerful subsea tractor, the largest free stream tidal turbine and three deep seabed mining vehicles. The latest in trenching technology includes the newly launched pre-lay plough configurable plough for boulder clearing, multi-pass trenching and backfill operations.



SMD

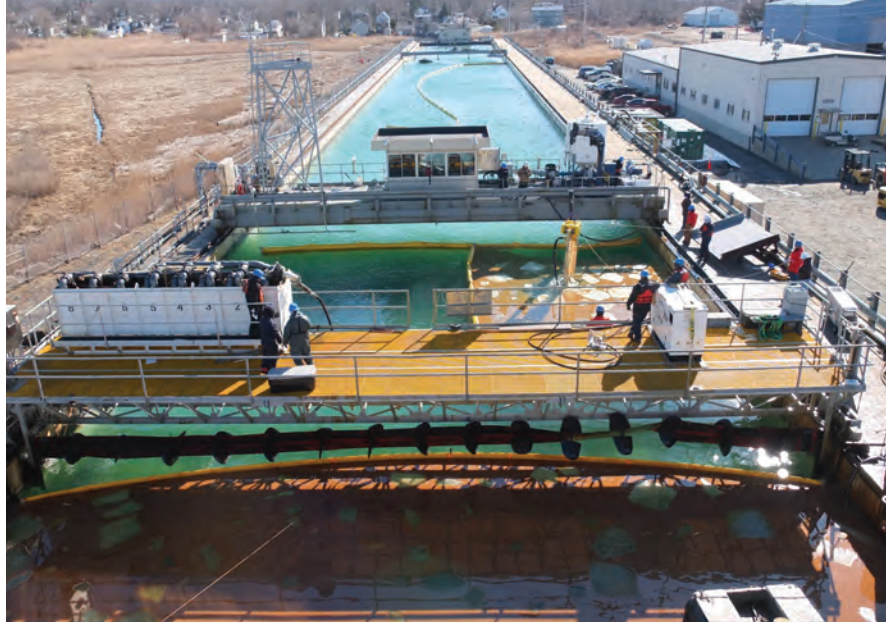
Ohmsett

Atlantic Highlands, NJ, USA

<http://ohmsett.com>

The U.S. Department of Interior, Bureau of Safety and Environmental Enforcement (formerly MMS) has operated the Ohmsett test facility for 25 years. It plays a critical role in the research and development of many effective response technologies enabling a rapid and efficient response to an actual spill.

Ohmsett provides independent and objective performance testing of full-scale oil spill response equipment and marine renewable energy systems (wave energy conversion devices). It is the largest outdoor saltwater wave/tow tank facility in North America and the only facility where full-scale oil spill response equipment testing, research, and training can be conducted in a simulated marine environment with oil under controlled conditions (waves and types of oil). Ohmsett's most notable feature is the above-ground concrete test tank measuring 667 x 65 ft. x 8 feet deep filled with 2.6 million gallons of crystal clear salt water. The facility also in-



Ohmsett

cludes conference rooms, maintenance/machine shop, and oil/water chemistry laboratory. The facility is equipped with a wave generator and three movable bridges with tow speeds of up to 6 knots, programmable to 1/100th knot increments, and a control tower that is fully computerized for collecting data from various sensors and video cameras for synthesis and analysis.

The Ohmsett test tank is large enough to accommodate many alternative energy devices, in particular wave energy conversion mechanical devices, in a controlled environment at meso-scale.

The advantage is that arduous scaling considerations are minimized, and validation testing is more realistic. In addition, Ohmsett provides a venue for first responders with the most realistic hands-on training available, enabling a rapid and efficient response to an actual spill event. With this hands-on training using real oil, participants are able to increase proficiency using booms and skimmers, practice removing spilled oil in harbor chop wave conditions, as well as analyzing skimming performance after collecting and measuring recovered oil.

SBG Systems

Yvelines, France • <http://www.sbg-systems.com>

SBG Systems celebrates 10 years of manufacturing innovative inertial navigation systems. In 2017 the company also moved into a new building. "Our production capacity has quadrupled. It allows us to follow our growth while maintaining short delivery times," said Thibault Bonnevie, CEO of SBG Systems. SBG Systems delivers high performance inertial navigation systems to the marine industry (hydrography, USV, AUV and ROV navigation, motion monitoring, etc).

SBG Systems is a leading supplier of MEMS-based inertial motion sensing solutions. The company provides a wide range of inertial systems from miniature to high accuracy. SBG Systems products are suited for aerospace, land and especially marine (surface and subsea) projects such as vessel motion monitoring, ROV and AUV control, hydrography and buoy positioning.

Apogee sensors are designed to be the smallest and lightest at this level of accuracy. It provides a roll and pitch accurate to 0.008° in real-time and integrates the last generation MEMS



SBG Systems

sensors and tri-frequency GNSS receiver for centimeter-level position and GNSS-based heading, not sensitive to latitude. The INS also deliver a real-time heave accurate to 5 cm in real time and 2 cm with the delayed heave feature.

SubCtech GmbH

Kiel, Schleswig-Holstein, Germany
<http://www.subctech.com>



SubCtech provides state-of-the-art ocean technology in two domains: rechargeable Li-Ion subsea batteries and environmental monitoring systems. Its batteries guarantee high-reliability and high-safety for AUVs or offshore oil and gas applications.

With 29 years of experience, SubCtech has established its position among leading manufacturers of ocean and subsea technology for industry and science, while still keeping its original company philosophy: “innovative, flexible and tailored solutions are the key to success in the field of ocean technology.”

SubCtech develops maritime technologies for industry and science in two domains:

- “Ocean Power” Market leader



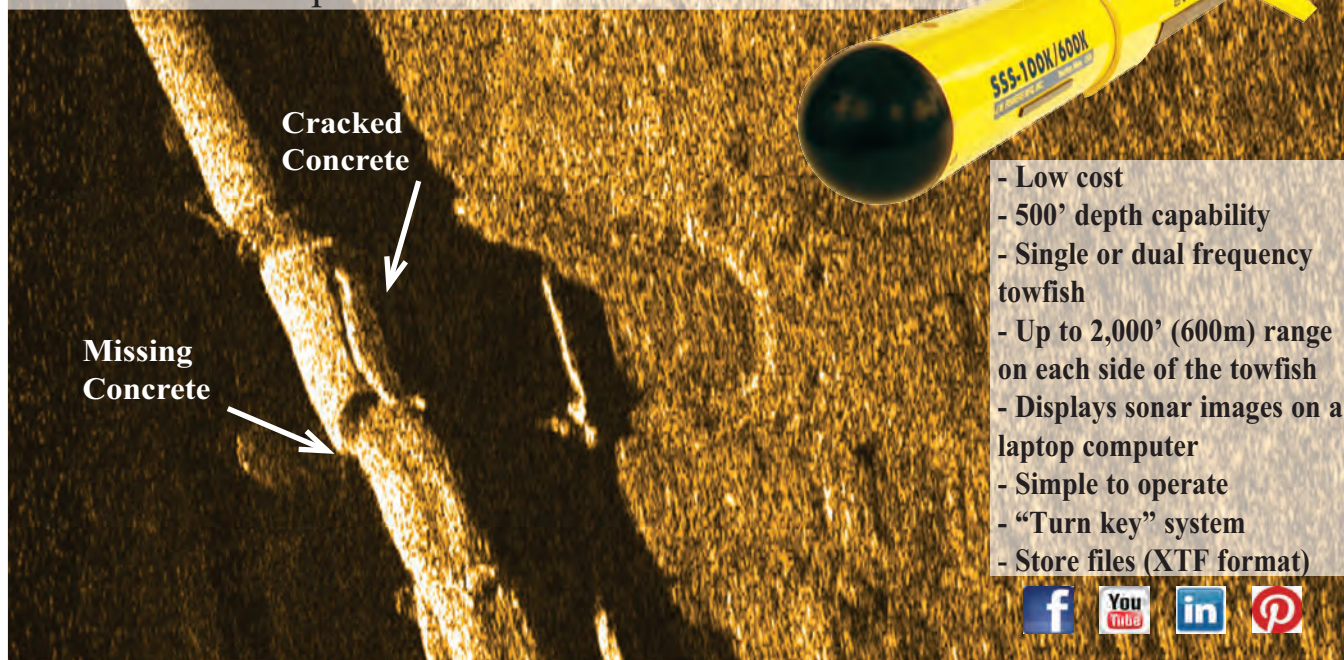
SubCtech

for high-efficiency, high-reliability and high-safety Li-Ion batteries, specialized for AUV systems and Offshore oil and gas applications.

- “Ocean Monitoring” Measurement systems for floating or submerged platforms such as vessels, buoys, landers, ROVs or AUVs.



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MASSA Products Corp.

Hingham, Mass., USA
<https://www.massa.com/>

Massa has more than 165 patents and more than 70 years' experience in innovating the field of electro acoustics. Massa has successfully performed on more than 650 sonar development and production contracts, and has received more than 100 contracts during the past five years. Massa develops many different ultrasonic & sonar transducer and system designs for use in gas and liquid. Massa was featured in *TIME* magazine 2Xs for amazing engineering and production feats.

Massa was founded in 1945 by Frank Massa, AKA "the Father of Modern Sonar Transducers." He co-authored the very first text book in the field of electro acoustics entitled, 'Applied Acoustics' (Olson & Massa, 1934). Frank Massa

was personally credited by the U.S. Secretary of the Navy in the 1950s for his work in sonar development and production. Frank, and his sons Frank Jr. and Don, have all contributed to the fundamental patents in electro acoustic design that have paved the way for sonar and ultrasonic systems development. Frank pioneered in the design and the produc-

tion of sonar and ultrasonic products; and today his fundamental values are still practiced at Massa Products Corporation. Massa is a family company with Don Massa (pictured above, left), CTO & President, and Dawn Massa Stancavish, (pictured above, right) Director, and New Products Manager.



Massa Products

Resen Waves

Lynby, Denmark • <http://ResenWaves.com> • Annual Sales: \$300,000.00

Resen Waves claims to be the first wave energy company in the world on its way to be commercial and profitable in 2017/18, based on a unique business model for wave energy and a low weight and very cost effective patented technology.

Resen Waves claims to have pioneered a new technology and business model for wave energy, which makes it possible to start in small scale and grow the business organically to big scale based on commercial terms, without feed-in tariffs. It is positioned as a low risk approach with a moderate investment level. The first commercial market, which Resen Waves addresses with small scale wave energy buoys, provides autonomous power and real-time data access to instruments and machinery in the oceans, which solves the hassle and cost of exchanging battery packs in the sea and not having real-time data access to the instruments. Business opportunities include: small scale buoys for autonomous instruments and real-time data connection: \$100 million market; medium scale buoys for replacing diesel generation in coastal areas and on islands, \$20 billion market, and big scale buoys for utility scale production at offshore wind farms (\$100 billion market).

Resen Waves has created the business foundation with a patented buoy technology which efficiently converts the horizontal and vertical wave motion into electric power with few



Resen Waves

moving parts and low weight, which is essential for future low-cost manufacturing and scaling of the business. When the wave pushes or lifts the buoy up and down the mooring line reels on and off a drum in the buoy and makes electricity with a direct mechanical to electric drive. The electricity is either feed to the grid or to an autonomous grid on the sea bed. A fiber optic link in the mooring lines provides real-time data access to the instruments or machinery in the sea. This technology allows us to operate small buoys in full ocean exposure, which is the key to starting small and growing the business to big systems in the future. The structural weight per kW generator capacity is only 300kgs, which is comparable with big scale wind turbines, and essential for commercialization.

RBR

Ottawa, Canada • <https://rbr-global.com>

Since 1976, RBR has been designing and manufacturing rugged, high precision sensing data loggers suitable for environmental, geophysical and oceanographic monitoring and survey work. All RBR instruments have been designed for easy use and require minimal service intervention. With minimal power use, they are optimal for long deployments ultimately minimizing operational costs.

All RBR instruments use a single piece of software: Ruskin, the one application that does it all. Deploy, download and display the data from a logger with ease. Free to download, users can even use Ruskin to simulate deployments.

All RBR loggers are lightweight, suitable for carrying to high mountain lakes or sending to deep ocean depths. Its larger instruments are used to measure up to 13 parameters, come equipped with fast USB download speed and a variety of other features such as optional Wi-Fi and twist activation.

Designed for the user, RBR's instruments track 1 – 13 parameters and provide accurate measurements in a single package. All RBR instruments are designed with several main features in mind; the rugged housing actively protects the device even when tested with harsh environments, and the large storage capacity and low power usage make the instruments optimal for long term deployments. In particular, the RBRconcerto C.T.D offers great flexibility with sample rates up to 12Hz, and excels as a compact profiler. With an accuracy of ± 0.003 mS/cm, the conductivity cell is built and calibrated for true oceanographic quality measurements. Likewise, its thermistors, with time constants up to 100ms, are calibrated to accuracy of $\pm 0.002^\circ\text{C}$. Pressure is measured with a piezo-resistive transducer with an accuracy of 0.05% of the full scale rating and achievable resolution of 0.001%. Ruskin, RBR's custom software which is available for PCs, Macs, Android and iOS devices make downloading and reviewing data effortless. Even if a person doesn't have an RBR instrument yet, they can download the free software and simulate deployments to estimate battery autonomy and memory usage for different scenarios.



Deep Ocean Engineering

San Jose, CA, USA

<http://www.deepocean.com>

Since 1982, Deep Ocean Engineering (DOE) has grown to become one of the leading manufacturers of sophisticated ROV and USV vessels that are used worldwide. Based in Silicon Valley, DOE is a technology-based engineering and manufacturing company that provides integrated robotic solutions for various underwater applications in harsh and diverse operating environments. Deep Ocean designs, builds and tests its remotely operated vehicles (ROVs) from its plant in California. DOE has sold more than 600 ROV systems in over 30 countries. Its ROV systems have been used in a broad range of industry applications: military, security, salvage, long tunnel and pipeline inspection, customs, nuclear and hydroelectric power plants, dams and lakes, offshore oil and gas servicing, scientific research and education, fisheries and broadcast filming.



InnovaSea

Boston, MA, USA • <http://www.innovasea.com>

InnovaSea is developing integrated, open-ocean aquaculture systems used to feed the world, creating systems that are scalable to efficiently and economically produce fish, while being environmentally sustainable. InnovaSea has one of the largest dedicated teams in the world working on open-ocean aquaculture systems.

InnovaSea Systems, Inc., a Cuna del Mar portfolio company, is dedicated to supporting open-ocean aquaculture businesses by producing innovative, environmentally-focused sustainable technologies and service solutions for the industry. Launched on January 1, 2015 with the merger of OceanSpar and Ocean Farm Technologies, InnovaSea is developing a fully integrated open-ocean farming platform. InnovaSea is furthering plans for outreach to aquaculture companies by accelerating research and development, advancing support for responsible aquaculture operations in the open ocean and using fully integrated fish farming platforms.

InnovaSea has a multidisciplinary engineering and science team developing integrated open-ocean farm systems. Its technical capabilities include ocean engineering, mooring design and analysis, aquaculture science, instrumentation, and data analytics. InnovaSea designs, analyzes and manufactures systems for all fish grow-out activities: containment, feeding, harvesting, mortality management and treatment. Its containment solutions for open-ocean aquaculture include the Aquapod and SeaStation. AQUAPOD Aquapod is a unique containment system for marine aquaculture, suited for open ocean conditions and a diversity of species. The Aquapod is constructed of individual triangle net panels fastened together in a spheroid shape. SeaStation SeaStation fish pens help farm operators reduce the total cost of grow-out on medium-to-high energy aquaculture sites. SeaStation's security and long service life allow capital costs to be spread across many years and harvests.



David Kelly

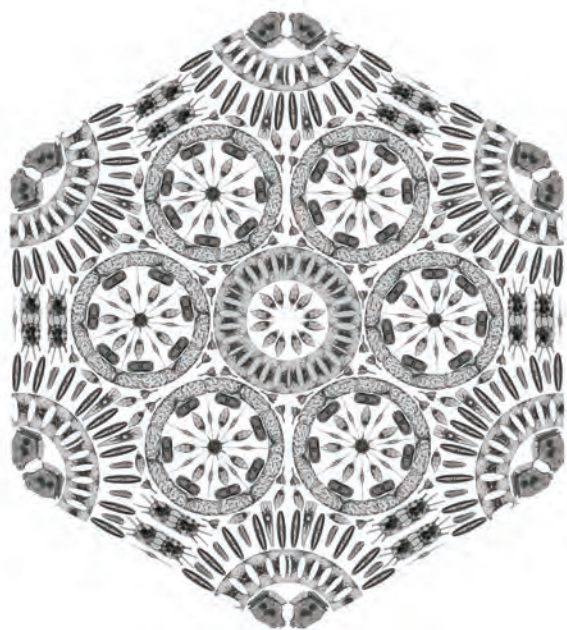
InnovaSea

McLane Research Labs

East Falmouth, MA, USA • <http://www.mclanelabs.com>

McLane Research Laboratories, Inc. was founded in 1983 to manufacture and develop advanced time-series instrumentation to the international oceanographic community. Through its long-term research, development programs, and association with diverse research projects, McLane has established a significant base of knowledge and proven technology in support of its objective. In addition to a number of successful technology transfers, the company maintains significant development capabilities.

McLane instruments are all designed to withstand the rigors of long term open ocean and freshwater deployments. The company produces three main product lines: profilers, samplers and flotation. Within profilers, McLane offers the Ice Tethered Profiler (ITP) and the McLane Moored Profiler (MMP). Samplers include our flagship Sediment Traps, as well as the Remote Access Sampler (RAS), Phtoplankton Sampler (PPS), and Large Volume Pumps. In addition, McLane's in-situ laboratory platforms, Environmental Sample Processor (ESP) and Imaging FlowCytobot (IFCB), support emerging genomic and optical research methods for automated time-series oceanography and limnology. McLane also manufactures glass and steel flotation, as well as custom instrument housings.



IFCB graphic made of IFCBdata.



McLane Research Labs

www.marinetechologynews.com

The New ROS P15 Pan & Tilt Positioner with...

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A smaller and smarter pan and tilt positioner with
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P15 contact: sales@rosys.com
or visit: www.rosys.com

HEADQUARTERS - San Diego, CA USA • (858) 565-8500

Klein Marine Systems

Salem, NH, USA

www.KleinMarineSystems.com

Klein Marine Systems, Inc. is a supplier of side scan sonar equipment and waterside security and surveillance systems. Klein's aim is one of creating reliable, leading-edge sonar products, and maritime domain awareness systems while offering top quality service.

Klein has more than 49 years of experience with the development and manufacture of high performance sonar products including side scan and bathymetry systems and maritime surveillance and security solutions. Its side scan sonar systems are deployed by governments, navies, port authorities, surveyors, oil companies and universities worldwide.

The System 5900 Multi-Beam Side

Scan Sonar represents Klein's advanced multi-function sonar platform and includes high resolution multi-beam side scan sonar, swath bathymetry sonar, gap filler sonar, and integrated tow body sensor and subsystems. The sonar employs advanced signal processing techniques and superior acoustic design to improve overall along track target resolution. The

UUV 3500 was developed as a side scan sonar with the unprecedented benefit of an advanced bathymetry payload for the growing AUV, ROV and UUV markets. The Klein Marine Systems HydroChart 3500 is a lightweight, low-cost, wide-swath, professional shallow-water underwater survey mapping instrument that supports IHO SP-44 Special.



Klein Marine Systems

D.O.D.S.

California, USA

"Leave it better than we found it." That's the core mission of the Deployment on Demand Spill Unit System (D.O.D.S.), a spill prevention and recovery system developed by Brad Diaz, Director Strategic Partnership at Advanced Innovative Recovery Technologies, Inc. (AIRTech).

Designed as an always ready unit for first responders, the D.O.D.S. is complete modular package compiling fast-deployable oil spill response equipment for ocean, coastal and inland waterway spill cleanup. Each D.O.D.S. unit includes the components necessary to deliver rapid and complete spill containment and recovery, and is deployed quickly and easily with as few as two people from shore or on board ships.

"Our solutions are based on the 'Golden Hour Rule,' having the right equipment at the right place in the hands of the right people," Diaz said.

Furthermore, D.O.D.S. units contain best achievable technologies in every category, Diaz said. "In an industry that relies on 60-year-old boom and sorbent technology . . . the development and introduction of the D.O.D.S. system became our call to duty."

"Our containment fencing is towable up to 8 knots with 94 percent greater effectiveness. Recovery is by plant-based foam booms holding 14 times their weight and has measurable results knowing recovered oil has value and is reusable. Our nontoxic herding/surface washing agent speeds recovery and restores for redeployment."



TE Connectivity (TE) SEACON

El Cajon, CA, USA • <http://www.te.com/offshore>



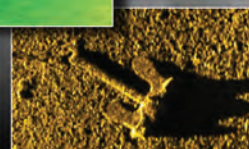
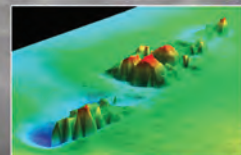
TE Connectivity (TE) SEACON

Founded in San Diego, the business soon took off expanding into international markets with great success and quickly becoming known as an industry leader in technology innovation, remaining at the forefront of the market. More recently, in 2014, SEACON was welcomed into the TE Connectivity family, joining TE as the go-to supplier for all subsea connectivity needs. TE's extensive range of SEACON products include electrical dry-mate, wet-mate and fiber-optic hybrid connectors suitable for many subsea applications including oil and gas, alternate energies, military, ROV/AUV, environmental and oceanographic, including exploration and survey. This product range coupled with constant innovation allows TE to continue as one of the leaders in connectivity.

The new SEACON HydraElectric wet-mate connector series has been designed, developed, tested and fully qualified in accordance with the latest industry standards, including ISO 13628-6 and API 17F SEAFOM. This

connector is available in ROV, stab plate and manual modes. The connector's modular construction with 4, 7 or 12 electrical circuits enables many configurations for use in electrical, signal and distribution networks in subsea control systems. TE's HydraElectric connector supports upcoming industry standards for subsea control system power distribution. Rugged marine systems require connectors with high speed communication capabilities and the ability to manage a range of operating currents. Qualified for both 1500 VDC and 1000 VAC pin to pin, the HydraElectric connector enables copper-based high speed Ethernet and supports the industry standards for Ethernet protocols, including CAN bus compatibility. This new connector range will enable customers to buy a complete scope, both fiber optic and electric distribution from TE, which now has the full product range for all electrical and fiber optical connectivity for subsea oil and gas.

Iver3 Autonomous Underwater Vehicles



**Rapid Data Collection For
Coastal Applications
Side Scan
Bathy Water Quality
Magnetometer**



OceanServer

www.ocean-server.com

508-678-0550

3D at Depth

Boulder, CO, USA • <http://3datdepth.com>

3D at Depth commercialized the first subsea LiDAR solution for the offshore oil and gas industry. Recently, 3D launched an inertial coupled moving platform solution that leverages the unique features of subsea LiDAR measurement and imaging technology paired with underwater vehicle delivery systems to collect more robust 3D subsea data sets. The technology was developed to help clients maximize offshore survey operations, while not compromising on data quality.

3D at Depth's portfolio of SL1 and SL2 subsea LiDAR laser systems delivers repeatable, millimetric, measured point clouds that allow clients to optimize subsea operations and maximize returns. Each LiDAR solution includes a subsea LiDAR scanner, hardware and powerful backend software. The flexible configuration of each system easily integrates into any subsea survey program. During survey implementation, subsea LiDAR capabilities allow for the collection of over 40 million data points in a reduced time-frame. The resulting high-density point cloud output generates a robust industry standard e57 format that includes geo-referenced spatial coordinates and the intensity of each laser pulse. (The intensity value is unique to the SL sensors as this information defines specific features including pipeline field joints, stenciled lettering on seabed structures and umbilicals.) With office locations in the U.S., U.K., and Australia, 3D at Depth serves a wide range of offshore industries and is focused on innovation and best practices to enhance 3D underwater data collection processes.

In April of 2016, 3D at Depth launched a commercial version of an inertial navigation system (INS) aided Subsea Laser (SL) mapping solution. The system incorporates 3D at Depth's SL1 subsea LiDAR system, a Phins INS coupled with a 1200 kHz DVL, iXblue RAMSES and a 3D at Depth Subsea FiT (fiber/time Multiplexer) consolidated into a tightly coupled unit. The solution leverages the unique feature of subsea LiDAR technology and was developed out of a trial that took place in December 2016. The trial validated both the capability of INS aided subsea LiDAR for a variety of applications including field mapping and spool metrology; and demonstrated significant time savings for high-resolution subsea mapping at altitudes from 2m to 20m with variable ROV speeds from ROV station keeping in heading control mode up to 2 knots. For the trial, a well center and pipeline were surveyed with 25 pipeline transits and 54 well center transits at differing altitude and speeds. Within the 10-hour trial, the INS aided 3D's subsea LiDAR system collected more than 200 million points in 79 passes at altitudes ranging from 2 to 20 meters. High-density point clouds were output into a robust industry standard e57 format that included geo-referenced spatial coordinates and each laser pulse intensity. Dynamic point cloud postprocessing showed a close correlation with existing static-scanned point cloud data for the same field. 3D at Depth will launch a spool-piece metrology solution later this year.

Neil Manning, CEO/President



3D at Depth

VideoRay LLC

Pottstown, PA, USA • <http://videoray.com>

VideoRay is a leader in micro-ROV technology and is constantly developing new ideas and accessories to help improve the underwater technology world. Its newest vehicle, the Mission Specialist Series, features modular components to enable larger, optimized vehicle configurations for even more demanding applications going beyond traditional observation class, extending into large payload, cavitation cleaning, extra-long tethers, and depths up to full ocean depth.

VideoRay introduced its first ROV in 2000 and has since become the world's largest volume producer of underwater ROVs, according to the company. VideoRay underwater robots help prevent terrorism, find and retrieve objects, inspect infrastructure both inland and offshore, and keep divers safe from hazardous conditions. As VideoRay innovates with new designs and functions, our ROVs assist in increasingly chal-

lenging situations and environments, and owners have learned to trust them to perform in more demanding missions. The hallmark of VideoRay systems are ruggedness, reliability, portability, and easy customization with the widest range of sensors and tools available for observation class vehicles.

As a leader in micro-sized ROVs, VideoRay systems support virtually every commercially available sensor or tool, and each can be fitted to systems as-needed, in the field, without modification of the base Pro system. Due to the overwhelming popularity of the VideoRay Pro system, VideoRay supports a wide range of vendors, and these vendors support VideoRay. With the Mission Specialist Series, customization and flexibility are key, with each system fitted to the sensors, tools, depth rating and thrust needed for the job at hand, rather than retrofit accessories to a standard ROV.

Scott Bentley, CEO/President



VideoRay



JW Fishers Mfg. Inc.

East Taunton, MA, USA • <http://www.jwfishers.com>

For more than 45 years JW Fishers Mfg has specialized in the design and manufacture of high-tech, reasonably priced underwater search equipment. Its side scan sonars, underwater metal detectors, ROVs and magnetometers are in use by commercial diving companies, public safety dive teams, government agencies, police and military units worldwide.

JW Fishers began manufacturing underwater metal detectors for recreational scuba divers. Demand for the products grew as commercial diving companies and police departments began asking for other types of underwater search equipment. JW Fishers expanded its product line to include boat-towed detectors, video systems, and ROVs. In the 90s R&D expanded into the sonar sector with com-

puters becoming smaller and more capable of data transfer. Today Fishers offers three high-tech, low cost side scan systems employing the most commonly requested frequencies: 100 kHz, 600 kHz and 1200 kHz. Low frequency provides long range, but lower resolution and high frequency gives the highest resolution, but shortest range; the middle frequency provides an optimal combination of both. Fishers scanning sonar systems are also popular with many public safety dive teams due to its lower cost. The newest addition to Fishers sonar product line is a Sub Bottom Profiler. The SBP-1 produces low frequency sound waves capable of penetrating through the ocean floor and producing images of objects buried under the strata layers.

Brian Fisher



Cathx Ocean

Naas, Kildare, Ireland • <http://www.catxocean.com>

Cathx Ocean manufactures the world's first integrated subsea machine vision system. It was founded in 2009 to develop fully integrated imaging and machine vision systems for underwater vehicle operations. The objective of this was to reduce the time and cost of performing subsea pipeline survey operations while also improving the quality of data obtained. Since 2015, the company has shipped more than 30 systems for AUV and ROV pipeline survey and is now expanding into other measurement, mapping and model generation applications. The company has manufacturing capacity for low or high volume and can also perform custom integration and development. The Cathx Ocean hardware products dramatically improve image quality and measurement capability underwater and the software products allow data processing and visualization.

Cathx Ocean's subsea imaging products allow AUVs and ROVs to capture high quality high resolution images and video by eliminating many of the fundamental limitations with conventional subsea cameras. Uniquely, Cathx Ocean imaging products acquire still images or video with very short exposure times. This enables them to also acquire full 3D spatially-registered laser profile information. This fully integrated system provides real-time 3-D point cloud synchronized with images at speeds of up to 5 knots. Each Cathx system includes camera, laser profiler and strobe lighting with full integration modules for electrical power data communication, software API's and fixed or flexible mechanical integration options. The company is working with current customers to release an automated mosaic software tool and a full 3D color point cloud capability in late 2017.





MetOcean Telematics

Dartmouth, NS, Canada • <http://metocean.com/>

For the past 36 year's MetOcean Telematics (MT) has led advanced ocean technology development in marine data collection and low power satellite telemetry solutions for autonomous systems. As one of the largest Iridium satellite Value Added Resellers in the world, MT has changed the way ocean research and operational experts receive their data.

MetOcean Telematics, headquartered in Dartmouth, NS, Canada, provides complete end-to-end telematics services, with a focus on niche MetOcean solutions and custom Defense and Security products. A manufacturer of Iridium satellite solutions, drifting buoys, beacons, and flashers, in addition to providing Iridium satellite airtime as a leading global Iridium reseller.

Through the development of its own drifting buoys for circulation studies and marine SAR, groundbreaking polar research systems to the renowned Novatech line of subsurface beacons

and flashers, the MetOcean Telematics brand is well recognized with many achievements:

- World's first Iridium-based Surface Velocity Profiler drifter - 2002
- The world's only supplier of a standard A-sized, air-deployable, GPS/Iridium Search and Rescue drifter
- Canada's leading supplier of Vessel Monitoring Systems and services for fisheries conservation
- The world's only Iridium-based Weapon's Firing System scoring system for Naval gun firing precession
- The world's deepest-rated Iridium-based subsurface beacon – Novatech Infinity



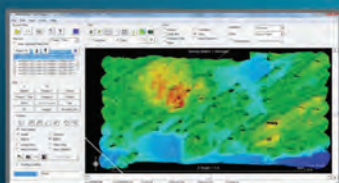
iCBN Novatech® Beacons



Iridium® Marine GO!

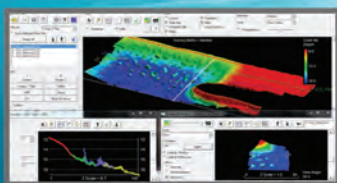


Iridium® Pilot



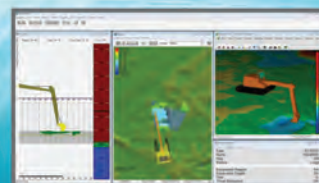
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MTR'S 17 'TECHNOLOGY DISRUPTORS'

Sometimes marketing catch phrases like 'Disruption' are bandied about with little regard to substance. In context of the MTR100, ***MTR*** seeks to shed insight on 17 truly 'disruptive' people, technologies and companies of 2017.

By Eric Haun, Kira Coley & Greg Trauthwein



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“Uberizing the Subsea Survey Sector”

Kraken Sonar

Karl Kenny is a ubiquitous presence in the subsea space, the energetic President and CEO of St. Johns, Newfoundland & Labrador based Kraken Sonar. Kenny is not remiss to share an opinion, and his opinion on the current status of the AUV market is simple. “The AUV business model as we know it is broken,” said Kenny. “It’s a long sales cycle, the vehicles are expensive and they are capital intensive,” and I think that’s why we haven’t seen a rapid uptake like the aerial (drone).

Kenny and his team at Kraken are focused on building its own fleet of deep diving AUVs and delivering to the subsea space “robotics as a service,” (RaaS). The “Uberization” of subsea vehicles if you will, a business plan centered on selling data, not vehicles. Kraken has dubbed the concept BOOMI, which means Build, Own, Operate, Maintain and Innovate.

The concept of selling data collected from the sea rather than vehicles is not new, a concept championed by Liquid Robotics, a Boeing company. Kraken’s concept differs in the fact that it will deploy a fleet of deep diving AUVs.

“This is timely, as we will be taking delivery of our ThunderFish Alpha drone later today,” said Kenny during an interview in mid-June. “This is a 6,000m rated deep water drone completely fitted with all the latest sonar (including Kraken’s AquaPix SAS), multi-beam, navigation and positioning technology.”

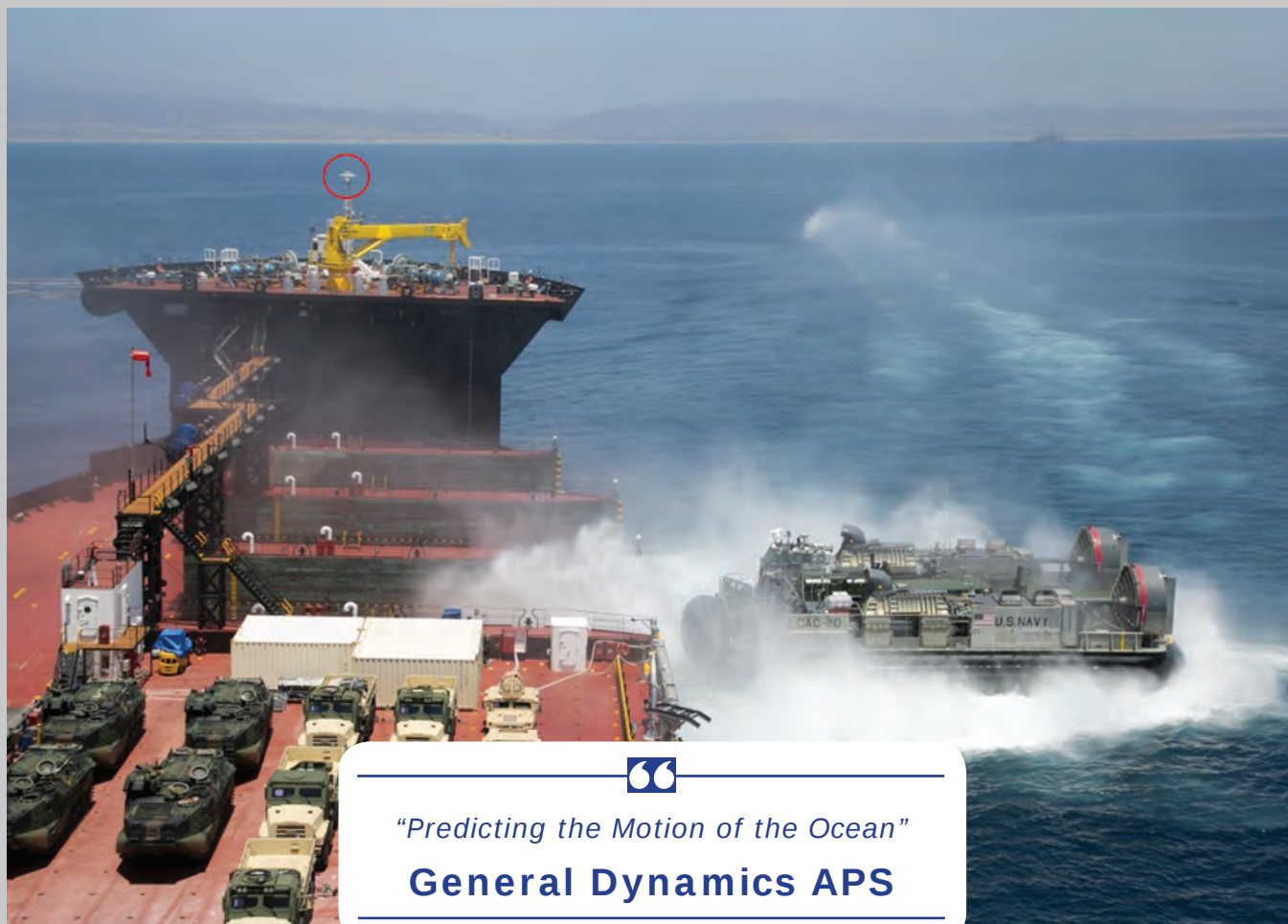
The RaaS offering that Kraken intends to build lever-

ages the cloud, making it possible for organizations to integrate robots and embedded devices into the web and cloud computing environments. “With RaaS, seabed mapping data captured by underwater drones can be stored on a cloud-based system and retrieved as needed by humans,” said Kenny. “This type of service can provide even more value if a company is operating a fleet of robots, each performing a variety of tasks. In fact, Kraken intends to design, build and operate its own fleet of underwater drones. It’s our objective to ‘Uberize’ the conventional ocean survey industry. This is generating a lot of attention in many ocean industry sectors, including O&G, offshore wind, commercial fishing, ocean science and military applications.” Kraken is backing its belief with investment, as Kenny terms it “investment in the core strategic components” including sensors, high resolution subsea laser, artificial intelligence scientists and engineers, and most recently battery and propulsion systems.

Kenny believes the time is right for the concept to boom, particularly in the oil and gas sector. The energy sector is entering its third year of energy price recession, and many companies are now resigned to the reality of the need to make a profit on \$50 per barrel oil. “They no longer can do things as they have done conventionally,” said Kenny, who believes that automation is the key to making offshore energy profitable at this new price point. “But to be honest, I don’t care if oil is \$1 or \$100 per barrel, because all of the subsea oil and gas infrastructure that is deployed today ... billions of dollars of pipeline, cable and wellheads, all of that still needs to be inspected. Here in St. Johns it is about \$100,000 to \$150,000/day dayrate to go out with a vessel for pipeline inspection. With an AUV, we can do that for a tenth of the cost ... \$15,000 to \$20,000 per day.”



Photo: Kraken



"Predicting the Motion of the Ocean"

General Dynamics APS

For thousands of years sailors have looked out to sea, anticipating the motion of their craft from the waves they see coming, deciding whether to perform an operation based on the visual. Could you do better than your eyeball for predicting when that next big wave is going to knock you off your feet? When the U.S. Navy started asking that question, the scientists and engineers at General Dynamics Applied Physical Sciences (GD-APS) began developing a system capable of predicting these large wave and motion events minutes into the future. The commercial variant of this system, FutureWaves was introduced to industry at the 2017 Offshore Technology Conference in Houston. The approach, originally developed under funding from the U.S. Office of Naval Research, uses a custom-designed X-band radar to see waves up to 5 km from the ship or platform where it is installed. With specialized computer processing, the measured wave field can be evolved forward in time, allowing prediction of the precise ship motions over much longer forecast intervals than previously available. At the core of the FutureWaves system are several key enabling technologies developed by GD-APS. The first is a customized X-band Doppler radar capable of sensing inbound ocean wave motions out to ranges approaching 5 km. The radar's azimuthal sweep rate and range resolution are set to adequately sample the local wavefield in space and time. Doppler scans are fed into a suite of real-time filtering and

processing algorithms that translate the radar data into forecasts of surface wave elevation maps and ship hull forces.

The radar-to-wave processing scheme uses an innovative least squares inversion to determine the underlying propagating components of the wave field, and these waves are evolved forward in time according to ocean wave propagation physics. A pre-calculated database of wave interaction forces with the ship is used to produce a rapid prediction of the ship's motion that will be induced by the predicted wave forcing. These continuously updating ship motion predictions can then be used to inform the timing of ship operations. Although maximum forecast time varies with sea condition and vessel speed, the FutureWaves system has been demonstrated to provide accurate, phase-resolved wave and ship motion forecasts to several minutes into the future.

The system also produces a directional power spectrum of the ocean waves, a map of where the wave energy is coming from and at what wave period. This wave spectrum data is fed to the ship motion model to produce a plot of the statistical representation of the ship motions as a function of ship heading and speed, allowing selection of ship orientation to minimize particular modes of motion. This planning tool is continuously updated from the radar-calculated directional power spectrum, and can also be fed wave spectrum forecast products to inform longer term planning.



“Creating Supervised Autonomy”

Greensea

As *MTR* reported on the cover of its March 2017 edition, Ben Kinnaman, CEO and President, Greensea is driven to bridge the gap between man and machine. No small task, for sure. But Kinnaman sits at the helm of a rapidly growing company, serving a market which is growing in stride. The Greensea story is compelling, as it centers on making subsea operations in all forms – scientific, commercial and military – more efficient and effective. Kinnaman and his Greensea crew are on a mission to have its software backbone OpenSEA become the de facto standard of subsea robotics and the marine industry. With Greensea’s software operators can now issue high level commands and the vehicle does the heavy lifting of performing the task, effectively putting the operator in charge of supervising the work as opposed to performing a second job vehicle operator.

Perhaps unique to the Greensea story is the breadth of its product and service offering for a small company. Though it is a software company, it is very hardware orientated, as Kinnaman explained.

“In the robotics world a software company is only as successful as the operator perceives it to be. Between software and the operator is hardware. So in the early days we found that for us to be as successful as possible, we had to own that hardware interface, as well. So we had to own the integration of the hardware, we had to own the delivery of the hardware, and we had to own the training

of the operator. We had to make sure the operator knew how to use our software in that hardware. That was a real differentiator between Greensea and everyone else, it remains our biggest differentiator and our biggest asset as a software company.”

The road ahead for Kinnaman and Greensea is filled with both promise and peril. The subsea robotics industry is still in its youth and filled with a high level of risk. Being a pioneer like Ben Kinnaman is neither fast nor easy.

“Our company, this technology, represents a big change of how we see operators using vehicles and equipment offshore: It’s a total paradigm shift. The way forward is to elevate the operator; the way forward is to get the operator out from behind a joystick, out from behind a console flipping switches and to get the operator into the position of doing their job – to manage the task. We want to get these operators away from worrying about flying a vehicle, to focus on mitigating a risk offshore.”

On the technology he said, “It is easy as engineers and technologists to get caught up in the ‘flashy’ portions of OpenSEA – the vehicle control and the inertial navigation and the sonar integration and the target tracking and the feature-based navigation. But at the end of the day, the fabric of OpenSEA is data fusion.”

And his vision for the future?

“Ten years from now, OpenSEA will be the standard operating platform of the marine industry. OpenSEA will be the architecture behind, certainly marine robotics, and I would say in a larger context, the architecture that operators go to for work offshore, and in the marine environment.” Watch a video interview with Kinnaman at:

<http://www.marinetechologynews.com/videos/video/man-machine-100021>



Photo: Greensea



“Connectivity as a Service”

KVH Industries

From humble beginnings KVH has evolved to become a central player in the maritime world’s global big data and autonomous revolution. **Martin Kits van Heyningen, founder, President, CEO, and Chairman of the Board** (pictured) met with MTR in Oslo to discuss.

In 1982, Arent, Robert and Martin Kits van Heyningen launched the world’s first digital compass for use in racing sailboats. The product and the company were both dubbed Sailcomp, and as products and applications were added the company changed the name a few years later to KVH Industries. Today KVH Industries is a manufacturer of solutions providing global high speed internet, television and voice services via satellite to mobile users at sea, on land and in the air. It is a manufacturer of sensors and integrated inertial systems for defense and commercial guidance and stabilization applications. “We still do quite a bit with sensors. The digital compass is where we started, and from there we moved to interfacing with the autopilot, the radar and eventually, antennas. That is how we got into the business of building antennas,” said Kits van Heyningen. “The technology today is different, but the focus on innovation (at KVH) remains the same”

Connectivity at sea is evolving in the commercial sector, and in the sectors touched by subsea – science, offshore energy and military – the ability to transmit information real-time is increasingly invaluable. With that, KVH recently introduced AgilePlans by KVH, an all-inclusive Connectivity as a Service (CaaS) offering. “It’s a new approach,” said Kits van Heyningen, noting that there are no installation costs, no hardware to buy and no long-term sign-up plan. “We tried to do something that no one else is doing. We are not content being a ‘me too’ company.” AgilePlans confirms this, as for a monthly fee starting as low as \$499 it brings an advanced satellite communications solution onboard with the aim of providing better communications and improved operational efficiency at sea. “We coined the phrase ‘connectivity as a service,’” said Kits van Heyningen.

In the subsea sector the KVH offering is broad, its work in autonomy is extensive, offering both sensing and connectivity solutions for drones, underwater vehicles and surface/swarm vehicles. From Sailcomp to swarm vessel technology, KVH’s inclusion as a disruptor is perhaps best summarized in its investment philosophy: “We tend to have a much longer horizon than other public companies. We still try to take (measured) risks, so if that means changing the company or taking a pause in your growth strategy, we’ll do that. You need to reinvent yourself.”

Photo: KVH



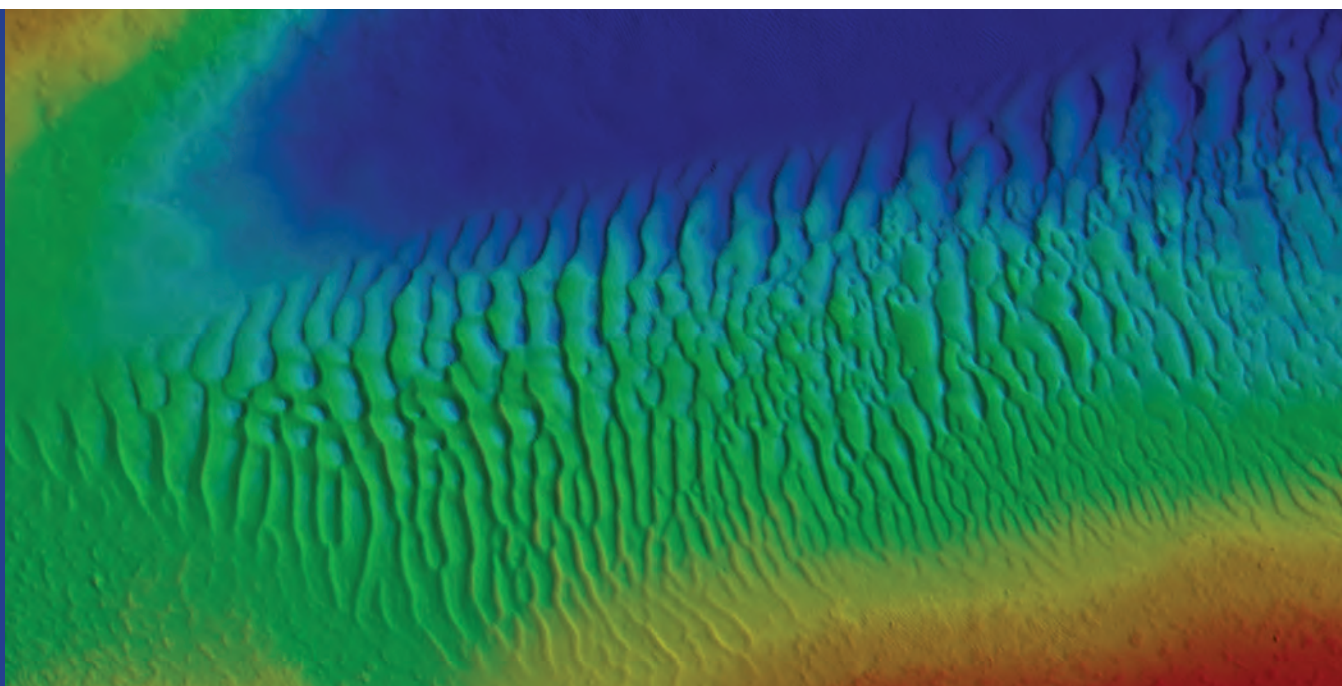


Photo: Teledyne Reson



"The SeaBat T-Series"

Teledyne Reson

Teledyne RESON SeaBat T-Series multibeam sonar system introduces new ways of expanding user's business, including faster setup times, better automation and higher quality and more versatile data. To this end, the SeaBat T-series is uniquely designed as a highly modularized sonar system with backward and forward compatibilities. The series includes:

- Integrated Dual Head SeaBat (IDH) T20-R & T50-R Multibeam Sonars
- Modular SeaBat T20-R & T50-R Multibeam Sonars
- Portable SeaBat T20-P & T50-P Multibeam Sonars

These new multibeam sonars are all built on the SeaBat T-series platform which is designed to deliver incredible data quality, enhanced sonar capabilities and a selection of sonar processors – all allowing users to configure the solution to meet needs and maximize investment.

The Portable Sonar Processor (PSP) forms the basis of the SeaBat T20-P, SeaBat T50-P single head for the highly portable survey solutions which combine portability and performance. The PSP is an essential organizational component that keeps data synced and time-stamped at a single source. The PSP is built for operators who need to mobilize quickly and is water resistant (IP54) which allows for a wider range of locations for installation.

The Rack-Mounted Sonar Processor (RSP) forms the basis of the SeaBat T20-R, SeaBat T50-R single head and

the Integrated Dual Head products. The RSP comes with an optional Inertial Navigation System (INS) for accurate sensor time tagging and motion stabilization securing minimal interfacing. The INS is fully integrated in the RSP which in total only occupies 2U in an industry standard 19-in. rack allowing you to save valuable rack space.

The modular design allows you to start out with a smaller SeaBat T20 and later upgrade your sonar simply by replacing the receiver array. Changing configurations between the super compact and lightweight 10 T20 configuration and the ultra-high resolution 0.50 T50 configuration is easy with the user friendly SeaBat Updater software.

The Integrated Dual Head SeaBat T20-R (IDH) and T50-R (IDH) are complete multibeam sonar survey systems, with one rack-mounted sonar processor running one fully integrated dual head sonar system. It provides maximized swath coverage of 220 degree and 1024 beams with advanced beam forming options. The built-in INS is pre-configured which together with the incredibly clean data makes the system easy mobilize and easy to use, allowing you to provide survey deliverables faster than ever before.



"Commercial Onshore Remote ROV Ops"

IKM Subsea

Norwegian ingenuity in the subsea space strikes again, as IKM Subsea, based in Bryne, Norway, has opened what it believes is the world's first commercial onshore controlled ROV operations. In the near future up to three work class





Photo: IKM Subsea

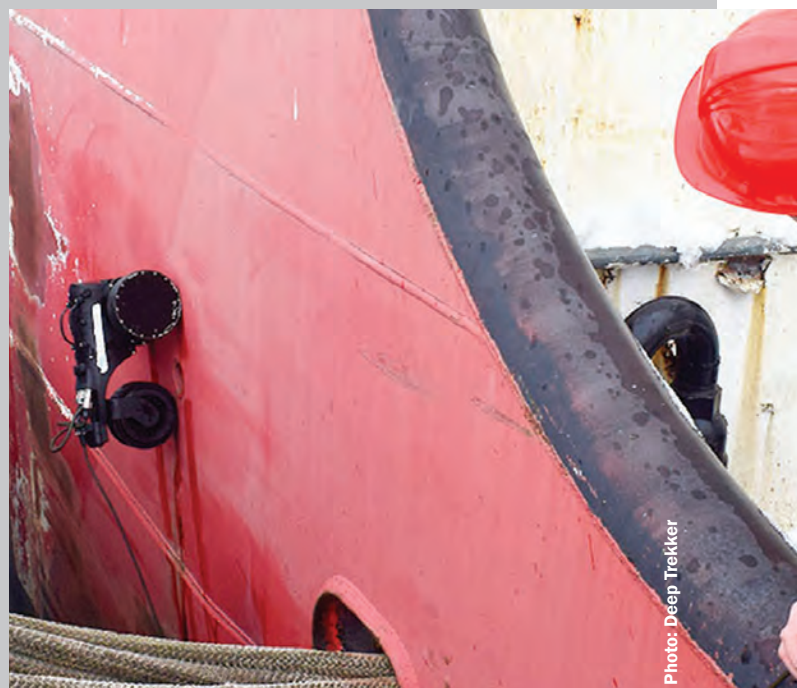


Photo: Deep Trekker

ROVs and one observation ROV on Statoil's Snorre B and Visund installations will be controlled from IKM Subsea's onshore control center. One of the work class ROVs (RROV) has been designed and engineered to be permanently based on the seabed and will only be brought to surface for periodic maintenance. The Company Acceptance Test (CAT) with Statoil was completed on June 12 with the ROV at Snorre B and the dual control center is now up and running. "We foresee a potential significant cost saving for our clients with less POB and increasing operational time offshore for the ROVs," said Hans Fjellanger Business Development Manager at IKM Subsea. "With this setup and proven technology in place we see this as the first of many stepping stones into the future of ROV technology for IKM Subsea."



"Submersible, Magnetic Robot"

Deep Trekker

Deep Trekker launched a new inspection vehicle at Nor-Shipping 2017: the Deep Trekker DT640 Utility Crawler, the first three-wheeled vehicle of its kind. Equipped with an HD camera, magnetic wheels and a multitude of application specific add-ons, the Utility Crawler can perform an array of tasks, making it versatile and easy to deploy at a moment's notice, the manufacturer said.

The Utility Crawler, designed and built by Deep Trekker, is submersible to 50 meters, and houses its own onboard bat-

teries, making deployment easy and quick for tasks such as contraband inspections and testing hull integrity or thickness. Magnetic wheels and various add-ons permit diverse applications such as scraping away marine growth or power washing the hull or examining for invasive species while in port. The Utility Crawler has both military and municipality applications as well.

- **Hull Inspection:** With magnetic wheels, the DT640 Utility MagCrawler can crawl along vertical angles to inspect the integrity of ship's hulls even underwater. Instead of dry-docking or returning to shore, crew can immediately inspect the hull if they fear something is wrong, via the live video on the handheld controller.

- **Hull Security Check:** When entering ports, authorities or crew can quickly check areas of interest for contraband, invasive species or security threats.

- **Remote Pressure Washing:** Outfit the DT640 Utility Crawler with a pressure washer to remove dirt, debris, rust scale and more all from piloting with the handheld controller.

- **Removing Marine Growth:** The dozer attachment is designed to remove hard marine growth by scraping surfaces with 50lbs of force.

- **Thickness Testing:** The DT640Mag Utility MagCrawler, can determine the thickness of metal on corroded and coated structure by mounting a thickness gauge probe on its arm. The magnets give the Utility Crawler the ability to travel in almost any direction on ferrous metal surfaces.

It's that time of year again when I search for the market's most exciting products. I was pleased to find that many of my top picks for 2017's most innovative companies have already been featured, including Hydromea, Kraken Robotik GmbH, Deep Trekker and Blueye Robotics. In this year's MTR100, I introduce just a few of the innovative products making waves across the market.

By Kira Coley



"Meet the FlowCam"

Fluid Imaging Technologies

Much of modern technology focuses on pulling data out of the oceans. What I love about this product is its combined ability of data gathering plus detailed analysis of that data. Fluid Imaging Technologies designs and manufactures the FlowCam, an imaging flow cytometer now used in over 50 countries around the world and on numerous ocean research vessels.

The FlowCam automatically and continuously detects individual waterborne organisms and takes a high resolution, full-color image of each. It provides more than 30 different measurements and can be trained to identify the species with the instrument's image recognition software, VisualSpreadsheet.

One of the most exciting things about the FlowCam beyond its technological abilities is the range of ground-

breaking research this technology has been central to over the last few years. FlowCam is ideal for detecting and tracking harmful algae blooms and studying the potential impact of climate change on marine life. NASA and other groups have been using the FlowCam to ground truth satellite imagery data and identify the composition of the open ocean phytoplankton communities.

Researchers can now see how different kinds of phytoplankton influence the optical properties of the seawater and can immediately examine whether an unusual community was related to the seawater or to the satellite images. The FlowCam technology provides high-resolution maps of phytoplankton that can be related to satellite data in more meaningful ways than possible before.

Harry Nelson, Fluid Imaging Technologies VP, said, "I'm really excited about the FlowCam 8000, (fourth generation instrument) that we launched last year. We have incorporated advances in technology along with input from our large customer base and have completely redesigned the instrument to provide for increased data throughput, high resolution images, increased flow cell lifespan and streamlined operations."



"The Submaran ... one of a kind"

Ocean Aero

Ocean Aero is a San Diego based company focused on accelerating discovery of our world's oceans. The award-winning Submaran is the product behind these aspirations – a vehicle for unmanned ocean exploration, both above and below the surface.

The Submaran is a powerful, hybrid, unmanned surface, and subsurface vessel – the only one of its kind – that has the capability to perform operations for months at a time. Completely scalable to fit customer's needs, the Submaran can host numerous sensors to provide versatility on missions.

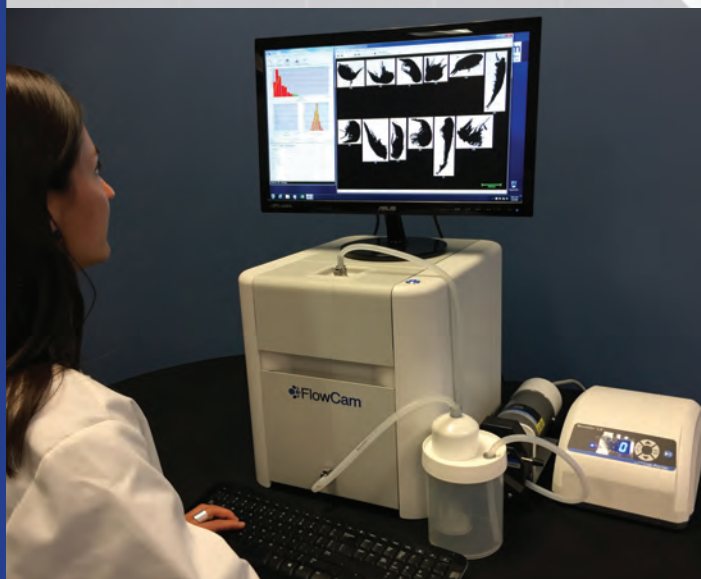


Image: Fluid



Image: Ocean Aero

Over the last year Ocean Aero has been extremely successful in two U.S. Department of Defense sponsored exercises. In 2016, the Submaran was the critical node in relaying instructions from a shore base ground control station to the Lockheed Martin Marlin UUV via underwater acoustic communications. In 2017, Ocean Aero partnered with SPAWAR Systems Center Pacific (SSC Pac) in integrating an unmanned aerial vehicle (UAV), Vapor. The UAV worked as a communications relay with the Submaran, allowing the systems to collect near real time information for the warfighter tasked with making mission-critical decisions.

Ocean Aero continues to improve all its products and capabilities. An Australia-based Ocean Aero operator successfully controlled a San Diego based Submaran through a full set of autonomous test and trial missions. This demonstrates the global coverage and abilities of the Ocean Aero systems from over 9,000 miles away.

Eric Patten, Ocean Aero CEO and U.S. Navy Captain (Ret.), said, "The thing I have enjoyed most is seeing the daily progress our team makes with the Submaran and how all the working parts come together to make an incredible product. I am proud of our team and I love seeing how we have pushed – and continue to push – the envelope on what we previously thought was impossible with the Submaran. Our engineers are always thinking outside of the traditional constructs of a 'boat' to creatively solve the challenges our customers are seeking to address. You can expect to see Ocean Aero continue to adapt and expand our capabilities in the future to suit the needs of various industries. We also envision a fleet of various sized Submarans that can be used together or alone to complete missions for customers."



"Snake-like vehicle Eelume"

Kongsberg Maritime

I spotted the latest addition to Kongsberg Maritime portfolio at the Ocean Business event earlier this year: a disruptive technology for subsea inspection, maintenance and repair (IMR). The Eelume is a totally new and unique concept for subsea intervention and as such looks and operates like no other marine robot before it.

Eelume vehicles are basically self-propelled robotic arms whose slender and flexible body can transit over long distances and carry out IMR in confined spaces not accessible by conventional underwater vehicles. Its ability to change its shape and hold postures allows intricate interactions using a diverse toolset including torque tools, grippers and specialized maintenance equipment.

The vehicles are engineered to live permanently under water, where they can be mobilized 24/7 regardless of weather conditions. Kongsberg Maritime are working closely with partners on the Eelume project, making progress with inspection and intervention capabilities that will be demonstrated later this year. Richard Mills, Director sales Marine Robotics, Kongsberg Maritime, said, "2017 has been an exciting year for spreading the message about exactly what Eelume can do. In February, we released the first footage of Eelume in action and the response we received from the industry was incredible. The footage captured at the PREZIOSO Linjebygg



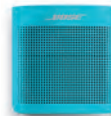
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Subsea Test Center during trials in the Trondheimsfjord shows the potential of the Eelume vehicle to significantly improve inspection and light intervention operations on subsea installations. We were also able to bring Eelume to our stand at the Ocean Business exhibition in April, and it proved to be one of the highlights of the show.”



“Fusion of Underwater Systems”

Impact Subsea

Impact Subsea was founded at the beginning of 2015 with an aim of creating truly innovative underwater products. Over the past year, the company has expanded its range of underwater altimeters, introduced an underwater Flooded Member Detection (FMD) system, and bought a new highly compact and high accuracy heading, pitch and roll device to market, the groundbreaking ISM3D. The unit is extremely compact, at just 65mm in length and depth rated to 6,000m. This makes the unit ideal for all underwater vehicles. There is also an OEM version for direct integration into the smallest of AUVs and ROVs. The

65 mm



Image: Impact Subsea



Image: Kongsberg Maritime

product's weight also adds to its unique features. The Titanium unit is just 0.33 kg in air or 0.225 in water, and the Delrin unit – depth rated to 1,000m – weighs less than half of this. Based on the latest in MEMS technology, the unit encompasses high grade gyroscopes, accelerometers and magnetometers. A highly advanced fusion algorithm is used to provide highly stable and accurate heading, pitch and roll (heading to $\pm 0.5^\circ$, pitch and roll to 0.05°).

Operating within the SeaView software platform, or interfaced directly to a third-party system. This allows the ISM3D to easily be installed in any subsea vehicle with no re-engineering of the system required.

Ben Grant, Impact Subsea Managing Director, said, "As a technology driven business, seeing our products being quickly and successfully integrated into customers underwater vehicles has been very rewarding. The ISM3D has several unique technical capabilities that you can't find anywhere else in the market."



"Fusion hybrid vehicle"

Strategic Robot Systems

Strategic Robotic Systems, Inc. (SRS) has created the all new FUSION, a breakthrough in hybrid underwater vehicles. The design philosophy is a direct response to global needs and years of maritime experience. Breaking from tradition, the FUSION is a unique combination of multiple underwater systems, blended into a single platform.

Beyond the ability to operate in AUV, ROV or Diver Navigation mode, the FUSION exemplifies attention to detail, integration, capability, and intuitiveness. A comprehensive suite of high-end sensors, intelligent control system and single user interface provides operators with an exceptionally capable tool. The fresh approach and departure from traditional UUV design will help further the usefulness of underwater systems across a diverse range of applications.

The creation of a single operating platform demonstrates a modern approach that improves efficiency, reduces capital expenditure and training time; giving the operator greater mission capability and future expandability.

Company founder, Jesse Rodocker, stated, "FUSION represents the next generation of underwater systems designed to smartly use mature technologies, packaged in a way that gives the operator more capability and reduces complication and ownership costs. One of our biggest points of pride is being able to give the operator a useful tool that will not only conduct the mission, but allow future planners to use the asset in new and expanding ways across their operations; delivering on that is very rewarding."

Deliveries of the first systems to customers will begin in the Q3 2017.



Image: Strategic Robot Systems

Ocean Engineering

subCtech
Subsea Technologies

pCO₂ Analyzer

pCO₂ Analyzer

- Auto-calibration & cleaning

Li-Ion Batteries

- Highest capacity, reliability, safety
- Your power source for subsea, AUV, ROV

OceanPack™ FerryBox

Subsea Sensors

AUV Batteries

Battery Systems

Added Value

- MIL-STD, API17, ISO 13628 approved
- IPC class 3 production
- Customizing and personal support

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By Eric Haun



“Award-winning Wave Energy Tech”

AquaHarmonics

Emerging triumphant from the pool of 92 teams competing in the U.S. Department of Energy’s (DOE) Wave Energy Prize competition, a duo from Oregon, Alex Hagmuller and Max Ginsburg – together AquaHarmonics – were named the winners of the \$1.5 million grand prize for their wave energy converter (WEC) concept, a point absorber with latching/de-clutching control.

With the goal of accelerating the development of wave energy converters that will ultimately reduce the cost of wave energy in the U.S., the competition officially kicked off in April 2015, followed by more than a year of designing, building and testing that eventually narrowed down the competition to nine finalists and two alternates. These teams received up to \$125,000 in seed funding to build scaled prototypes of their wave energy converter devices. With the support of the U.S. Navy, the finalist teams tested their prototype devices at the nation’s most advanced wave-making facility, the Naval Surface Warfare Center’s Maneuvering and Seakeeping Basin at Carderock, Md.

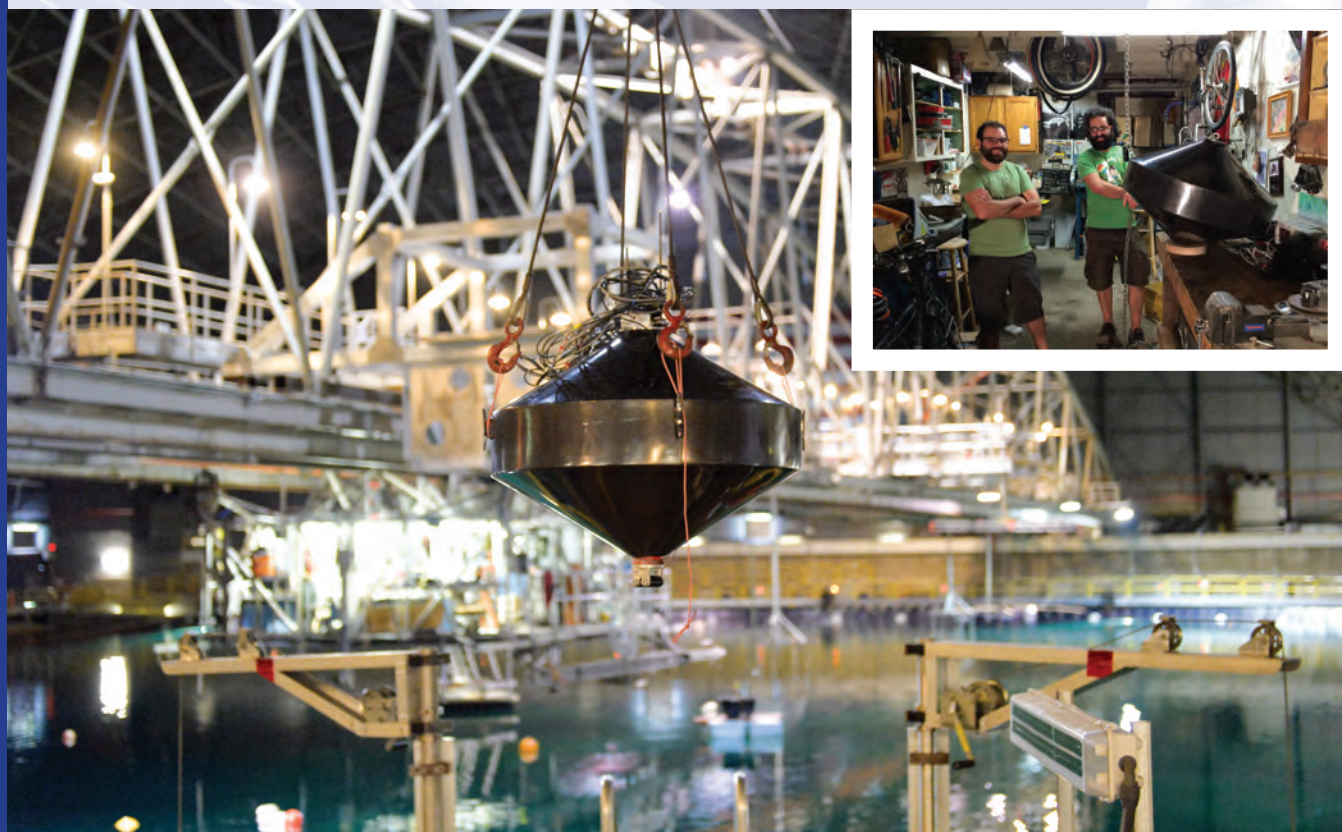
Hagmuller and Ginsburg’s work together predates the

start of the competition, stretching back about five years, when Hagmuller started to build small scale wave energy prototypes and enlisted Ginsburg, a friend from Oregon State University, to help design the electrical components and software. Together they built and tested several different wave energy prototypes, and the knowledge gained from each has led to many improvements and changes in the design.

“The AquaHarmonics wave energy device is an axis-symmetric point absorber with a winch-like power take-off. The device is unique in that it utilizes a control system that allows the power take off to operate with bidirectional power flow to achieve a resonant state with the wave climate, thereby increasing net power output over a non-resonant, passively operating point absorber,” Hagmuller said. “In addition, the device is designed to have no end stops within its operational range of wave climates, including storm waves, as well as the ability to de-tune in storm conditions to reducing loading on the mooring lines.”

According to the DOE, AquaHarmonics won the contest by demonstrating a five-fold improvement in energy capture per unit structural cost.

AquaHarmonics has since been awarded more funding from the Energy Department and will set out to upscale its winning device for testing in the open ocean.



Background image: © kentoh / Adobe Stock

Images: Aqua Harmonics



Image: Hydromea



“Meet the Vertex Swarming AUV”

Hydromea

Hydromea co-founders Alexander Bahr and Felix Schill have introduced the Vertex autonomous underwater vehicle (AUV) featuring the first real swarm capability, and with it have taken a new approach to increase sampling density when surveying the water column for physical-chemical parameters.

Combining years of research in distributed localization and underwater mesh communication with hardware engineered to leverage the results of this work, the Swiss duo have developed a proprietary AUV designed to operate in large groups of 20-50 units or more. The very small 70cm AUV weighs only 7kg and maintains high navigation accuracy without large and costly navigation equipment such as FOG and DVL. It also provides intra-vehicle communication for sophisticated cooperative behaviors without the need for large and expensive acoustic modems.

Hydromea said it will use a large swarm of these AUVs to provide an underwater sensing service, collecting physical/chemical water quality parameters with very high spatial resolution and at much reduced per-sample cost when compared to existing methods. The data is collected in many locations in parallel and can thus provide an accurate snapshot of fast changing phenomena.

“This data will visualize complex outflow plumes of water-treatment or desalination plants which are critical for pre- and post-construction impact assessment and are currently only obtained through sparse sampling and complex simulation/modeling,” Bahr said. “The swarm is also well suited to col-

lect data for explosive ordnance disposal (EOD) as the short detection range of the used magnetometers makes a typical EOD-survey very expensive and time-consuming.”

Vertex is designed to be replicated using mass-production processes, and Hydromea has even spun off several of its technologies into self-contained products.

The LUMA 250LP is a compact 6,000m-depth rated optical modem for fast short-range underwater communication. Its low power-mode makes it suited for the deployment with battery-powered equipment.

The patented DiskDrive thruster’s low cross-section makes it well suited for low-drag control thrusters and its hub-less design minimizes the risks of blockage through debris. Its built-in CAN-bus based motor controller simplifies integration and the hall sensor allow for quick reversal and precise control at low speeds.



“The Experienced Newcomer”

M2 Subsea

M2 Subsea is a new name in the subsea services business, but a look within reveals no lack of experience. The company’s CEO, Mike Arnold, has worked in the subsea sector for more than 35 years, and now with his team of industry veterans, formed M2 Subsea, an experienced newcomer.

Entering a downturned market, M2 Subsea set out in 2016 as a new, differentiated player in the ROV marketplace. Backed by private equity firm Alchemy Special Opportunities, the company acquired 32 ROVs from distressed Norwegian company Harkand. These ROVs, which range from observation

class to work class, were purchased “at the right price,” Arnold said, “which enables us to put those into the market at the correct selling rate.”

“The market is extremely cost-conscious at the moment, and our clients are basically driving down costs as much as they can because they’re suffering as well from the low oil price. So we have to respond accordingly,” Arnold said.

“We’ve got a fresh approach to the business, the correct asset approach, extremely lean overhead and an extremely experienced management team,” Arnold said. “We can dramatically reduce the cost but still provide a very professional, cost-effective, but more importantly safe, service.”

To do this, Arnold said M² Subsea has formed a “new model” that includes collaboration and marketing agreements with vessel operators globally. “Instead of us chartering vessels, we’re working with vessel operators to place our equipment on those vessels,” Arnold explained. “It’s a win-win situation. We pay for the vessel when we use it, and vice versa; they pay for the ROVs if they get a contract. Everybody is covering their costs, and we all partake in the upside.”

Of course, there’s much more to the mission of M² Subsea than merely driving down the cost of ROV services. “It’s not just a case about cutting margin, cutting rates and winning the work. We’ve got to be smart about how we work and look at innovations to make the job more effective for ourselves and for the client.” In addition to developing new and innovative technologies and tooling, Arnold explained this could mean combining projects with different operators, for example.

The company, which currently operates out of hubs

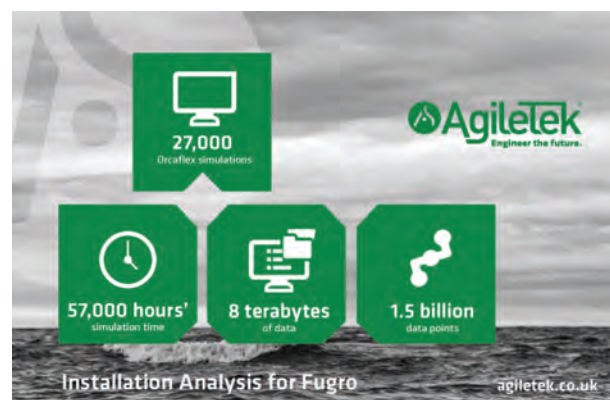
in Houston and Aberdeen, is eyeing new opportunities around the globe. “We’d like to expand our global footprint into other regions like Australia and Singapore, covering the Asia Pacific region, but also taking a good look at the Middle East and India as well.”

“We want to expand our service offering, we want to add more ROVs to our fleet, we want to add more collaboration agreements and basically expand our wings globally.”



“Big Data Takes to the Cloud”

AgileTek



Images: AgileTek

Subsea engineering analysis consultancy AgileTek has recently used for the first time its innovative online platform AELCloud, which has been designed to run analysis and simulations on clients’ local servers and the cloud, greatly reducing required simulation time and ensuring information is high-quality and traceable.

A recent project for Fugro required many simulated subsea power cable installation operations to be performed to verify procedures, component sizes and weather windows.

For this, AgileTek rolled out AELCloud and was able to scale server capacity on demand.

On this subsea installation project alone, AgileTek said it ran approximately 27,000 OrcaFlex simulations which equated to around 57,000 hours, or just over six years of simulation time. Eight terabytes of simulation file binary data were saved, and AELCloud processed a total of 1.5 billion data points for critical metrics in the system.

AgileTek noted that data at this scale cannot be stored on a laptop or processed with Microsoft Excel, which is why it invested in a distributed digital data store with built-in redundancy and a highly efficient query language.

AELCloud, which took about a year to develop, enables all data transfer, results specification, results post-processing and reporting to be performed automatically on a secure web application, effectively slashing the number of manual steps required to report results.



Images: M2 Subsea

“I’d seen too many projects over the years where the time to process simulations resulted in delays that impacted project milestones, production slots and vessel availability,” said Steve Rossiter, AgileTek’s managing director. “Constraints on storing and processing data also cause analysts to make assumptions about what data is worth processing and what isn’t. In the age of big data, these delays and limitations should not exist and so we built AELCloud to take advantage of this new wave of technology.”



“Risk-based abandonment of Wells”

DNVGL

Case studies presented by DNV GL show the Recommended Practice (RP) on risk-based abandonment of offshore wells, in combination with optimized project execution and new technology, can reduce plugging and abandonment (P&A) costs – the highest cost within field decommissioning – by as much as 30-50 percent.

“The costs related to well P&A are enormous,” said Per Jahre-Nilsen, Global Drilling and Wells - Business Development Manager, DNV GL – Oil & Gas. “We believe the time has come to tackle this issue head on by assisting regulators and the industry to establish a new methodology for dealing with the decommissioning of wells.”

Offshore wells vary greatly in terms of complexity, and often the complexity of P&A operations necessary for abandoning these wells vary accordingly. However, current P&A requirements are the same for all types of wells, representing conservative interpretation of past experience and outdated technologies, DNV GL said, adding practice also differs from country to country.

In contrast to the prescriptive one-size-fits-all methodology present in the industry today, the framework outlined in DNV GL’s RP ‘Risk based abandonment of offshore wells’ (DNVGL-RP-E103) offers the possibility for individualized, fit-for-purpose well abandonment designs with P&A requirements that differentiate on a well-by-well basis.

“Risk-based approaches are widely used in all other offshore disciplines, ensuring appropriate long-term environmental protection and also representing the most efficient method to ensure safety. It is time to apply these principles to P&A,” said Elisabeth Tørstad, CEO of DNV GL - Oil & Gas.

Working with oil and gas operators, regulators and other industry players, DNV GL said its new RP defines key steps of risk-based methodology that assess the well barrier failure modes, well flow potential, valued ecosystem and safety components, dispersion modeling and impact analysis.

DNV GL proposes that the tailor-made design solutions made possible by the alternative risk-based approach not only better suit each specific well, but by calculating the environmental and safety risk levels for the proposed well-specific solutions and cross-checking them with the risk acceptance



© Michael Flippo / Adobe Stock

criteria, more cost-effective solutions can be created.

“By using this method, hazardous wells will get the attention they deserve, and benign wells will avoid excessive rig-time and expenditure. We’re looking at potential cost savings of more than \$32 billion on the NCS alone, and even more globally,” Jahre-Nilsen said.

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SeaView Systems



SeaView Systems, Inc.

Dexter, Michigan, USA

<http://www.seaviewsystems.com>

SeaView Systems, Inc. , founded in 1998, is a provider of oceanographic and underwater technologies and services. It designs and builds custom ROVs targeting specialized applications where standard production ROVs cannot address the specific requirements of a particular mission. It provides services such as ROV tunnel or structural inspections using precisely located HD video or 3D sonar mapping or other techniques. Its engineering capabilities include expertise in electronic, software and mechanical design. Incorporated into these capabilities are electro/mechanical assembly and integration, machining and fabrication. And it designs and sells a range of specialty electronics for various oceanographic, ROV, and survey applications tailored to the underwater technology industry. S

SeaView's expertise includes ROV operations and high-end underwater surveys including the use of inertial navigation systems (INS) for geo-referencing, 3D sonar, and laser modeling. Its in-house developed custom vehicles include Titan, a battery powered, umbilical-free ROV capable of tunnel inspections greater than 10km and SurfROVer, a battery powered crawler for specialized applications such as route surveys and unexploded ordinance (UXO) surveys and for deployment of a cable/pipeline tracker as well as applications in otherwise impassible surf such as active surf bathymetry surveys. Its custom electronics are used to advance the state-of-the-art capabilities for ROV communications, metrology and oceanographic industrial and research applications around the world.

Southwest Research Inst.

San Antonio, Texas, USA

<http://www.swri.org>

SwRI has served the underwater community for more than 50 years, pro-



Southwest Research

viding testing, design, fabrication, and analysis. SwRI built a quarter-scale model Seawolf; the largest unmanned underwater vehicle at the time; and a remotely operated submarine rescue vehicle. It also built the deepest diving research submarine used in the U.S.

Southwest Research Institute (SwRI) is an independent, nonprofit research and development organization offering multidisciplinary services leveraging advanced science and applied technology. Headquartered in San Antonio, Texas, it is a client-focused, client-funded organization and occupies 1,200 acres, providing more than 2 million

square feet of laboratories, test facilities, workshops, and offices. SwRI provides services to help manufacturers design, develop, and test high-quality offshore technology products that enable safe and reliable production of energy in the harshest environments. Its labs simulate deep ocean effects on offshore equipment such as pressure hulls and vessels. In its deep water simulation facilities, it evaluates pipes, flow-lines, and valves under extreme conditions such as those found in deep-offshore environments. Its pressure simulation services include structural analysis and experimental strain/stress measurement technology, deep ocean pressure simulation testing, test services for offshore insulation and corrosion protection systems, performance verification testing of valves and components, and standard tests for offshore equipment. Its Ocean Engineering and Structural Testing Laboratory has more than 10,500 square feet of climate-controlled laboratory space with additional outdoor test facilities. Its deep-ocean pressure simulation test chambers range from 90 inches inside diameter and 20 feet deep, to 16 inches inside diameter and 30,000 psig, that enable it to conduct static testing, cycle testing, and destruction testing.

SubC Imaging

Clarenville, Newfoundland, Canada

<http://www.subcimaging.com>

Simply put, SubC Imaging creates some of the most advanced underwater imaging systems in the world. In its seven years, SubC has continued to push the



SubC Imaging

envelope in what is considered state of the art underwater optical technology. From its underwater cameras to media management with its DVR/Overlay system, SubC continues to innovate with new features and capabilities for a wide variety of underwater platforms.

SubC is proud of to be a part several high profile international projects including the search for Amelia Earhart's plane and a survey of Australia's World War II light cruiser, the HMAS Sydney. SubC has also had extensive involvement with ocean observatories including Ocean Networks Canada's Neptune and University of Washington's Regional Scale Nodes.

Subsea Tech

Marseille, France

<http://www.subsea-tech.com>

Subsea Tech has been designing and manufacturing mini-ROV and USV for scientific, civil and defense market for more than 10 years. It is based in Marseille, an engineering company specialized in marine and underwater technologies with three main activities:

- **R&D:** development of bespoke solutions to answer specific needs in underwater observation, intervention or monitoring based on customer supplied specifications.
- **Production:** fabrication and support of small and medium series of mini ROVs, unmanned catamarans (USV) and underwater cameras.
- **Intervention:** underwater inspection services with a team of professional pilots for video/sonar inspection, bathymetry, mainly on civil works like ports infrastructures, dams, bridges, locks, canalizations, water reservoirs, etc.

Products include:



Southwest Research

- **mini-ROV:** Subsea Tech offers a full range of ultraportable mini-ROV (Guardian, Observer, Sentinel) to carry out visual and sonar inspections down to 150m depth.

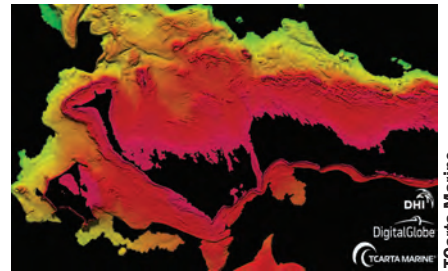
- **USVs:** Subsea Tech proposes two models of small catamaran type USV: Catarob and CAT-Surveyor. Catarob is a light and easy to transport (50 kg/1.8m), able to embed up to 15kg of payload. CAT-Surveyor is larger (270kg/3m), designed for harbor and coastal area surveillance survey. It has a payload capacity of 80 kg.

TCarta Marine

Didcot, Oxfordshire, UK

<http://www.tcartamarine.com>

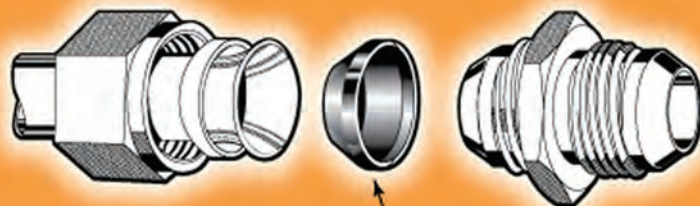
TCarta Marine LLC of Denver merged with Proteus Geo of Oxford, UK, to create a global mapping company that provides bathymetric and marine data sets from the shallow coastal zone out to the continental shelf. Its new BATHYMETICS portal is a unique instantly accessible off the shelf global bathymetry product. The organization provides product lines that include high-resolution satellite-derived water depth and seafloor map products, as well as 90m and 30m GIS-ready bathymetric data aggregated from numerous information sources. TCarta Marine have completed numer-



TCarta Marine

ous bespoke satellite derived bathymetry projects around the world, providing data in shallow water locations difficult to access with a survey vessel. Large areas can be produced very quickly at a fraction of the cost of traditional survey methods. TCarta Marine are now working in partnership with DHI Group to create a global satellite derived bathymetry database. All depths are extracted from DigitalGlobe WorldView-2 and WorldView-3 multi-spectral satellite imagery using a customized, proprietary algorithm, and then a modeled tidal adjustment is applied. The technology allows data to be produced to 20m water depths (where conditions allow), every two meters on the sea floor, and through a European Space Agency funding program data will be available instantly through an online portal. By the end of 2017, the TCarta Marine team will have produced more than 100,000 sq. km. of data in various shallow water locations around the world.

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Rowe Technologies

Poway, CA, USA

<http://rowetechinc.com/>**Annual Sales: \$4,000,000.00**

Rowe Technologies, Inc., founded by Dan and Steve Rowe in 2009, is a private company. Dan and Steve Rowe are the sons of Fran Rowe, the originator of the Acoustic Doppler Current Profiler (ADCP) and the Doppler Velocity Log (DVL). RoweTech employs a highly experienced, innovative staff to develop, manufacture, market, and service leading-edge, high quality, sonar systems for worldwide use, in

oceans, lakes and rivers. RoweTechs' team is centered on advanced electronic engineering and signal processing development as well as acoustic transducer design and development of traditional and multi-frequency piston products and planar arrays. RoweTech's dual frequency instruments (offered in piston and planar arrays) provide high-resolution near field and long-range low-resolution current velocity measurements on the market. A vertical beam can be added to both a single set of Janus-configured beams [SeaWAVE ADCP] or two to sets of Janus-configured beams [SeaSEVEN ADCP].

**Rowe Technologies****Saab Seaeye Ltd.**Fareham, Hampshire, UK, www.seaeye.com

Saab Seaeye manufactures electric underwater robotic systems for markets including: oil and gas, renewable energy, hydro and civil engineering, marine science, aquaculture, nuclear engineering, telecoms, security and emergency, salvage, seabed mining, leisure and defense. Saab Seaeye has facilities in the U.K., Sweden and the U.S. and employs more than 250 people. It is a wholly owned subsidiary of Saab AB, listed on the Swedish Stock Exchange. Exports from Saab Seaeye stand at over 80% of sales with the company represented and supported in 25 countries around the world, and has an office in Houston. Founded in 1986, Seaeye has pioneered many innovations in the ROV industry, including:

- Brushless DC thrusters
- Polypropylene chassis
- Carbon fiber pressure vessels
- Distributed intelligence control system
- Fault-tolerant systems with self-diagnostics
- High frequency power distribution

More than 900 underwater systems have been sold, fitted with a range of standard and custom designed tooling and sensors that includes cameras, manipulators, survey sensors, cutters, tracking systems, sonars, torque tools and water jetting tools. The company also designs and manufactures a range of underwater vehicle handling devices including Tether Management Systems. The Saab Seaeye vehicle range comes in various sizes, power and tasking options that extend from man-portable inspection systems up to deep-rated work systems. They extend from tethered and autonomous to remote resident systems.

The overarching breakthrough that drives innovation, development and operations throughout the company is Saab Seaeye's iCONTM technology toolbox. It allows e-robotic systems to benefit from intelligent, behavior-based control

system architecture, which comprises a set of hardware and software building blocks that allow harmonious migration of concepts across different systems and accelerates future development innovation.

Simplifying and standardizing system architecture reduces the number of components and sub-systems, increases flexibility, promotes understanding, reduces risk during system development and makes it easier and faster to bring new products to market - and react quickly to changes.

As an intelligent control system, iCONTM, is a vital innovation that effectively enables a system to 'think for itself', leaving the operator free to concentrate on the task at hand.

iCON independently manages each device on the vehicle, including fault accommodation, as every device is aware of its own status, predicts failure and takes action as necessary to keep the vehicle working, even with multiple equipment damage. Its range of vehicles include:

Name	Thrusters	Rated (m)
Falcon	5	300 & 1000
Tiger	5	1000
Lynx	6	1500
SeaOwl XTi	6	3000
Cougar XT	6	2000
Cougar XT Compact	6	300
Cougar XTi	6	3000
Panther XT	6	1500
Panther XT Plus	10	1000
Leopard	11	3000+
Jaguar	8	3000+
Sabertooth	8	3000m
HyBIS	0	6000

RS Aqua

Alton, Hampshire, United Kingdom

<http://www.rsaqua.co.uk>

Annual Sales: \$5 million

RS Aqua (U.K.) has been supporting most sectors within the marine technology space for 35 years. A U.K. marine technology supply company, RS Aqua have made its name by providing high-end sensors and equipment and by supplying a suite of technical support services that complement and enhance their product. For its important domes-

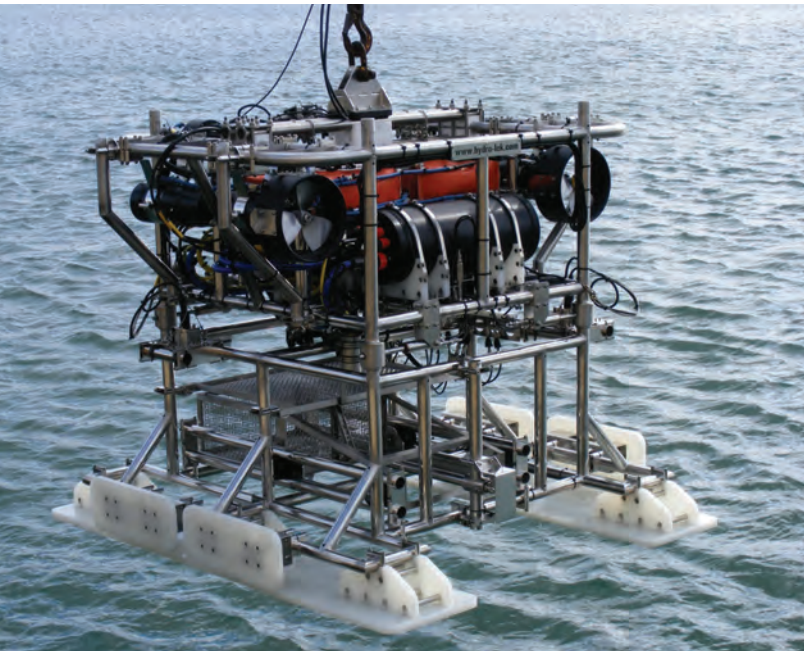


RS Aqua

tic market, RS Aqua acts as a distributor and value added reseller, representing a network of outstanding partner companies. In collaboration with leading manufactures and also with end-users,

RS Aqua have also developed its own products for global export. This export trade has greatly enhanced RS Aqua's core engineering and support capabilities, and has also ensured that RS Aqua is cognizant of the global marine technology market place, rather than just focusing on domestic activities.

RS Aqua products range from in water sensors, subsea power solutions, autonomous surface vehicles, satellite data and software. RS Aqua "own brand" products have been developed with partner companies and are supplied globally.



HYBIS



Jon Robertson, MD

SABERTOOTH



FALCON



Saab Seaeye

Alseamar



ALSEAMAR

Meyreuil, PACA, France
www.alseamar-alcen.com

ALSEAMAR has been successful over the past year: Its SeaExplorer glider continues to gain market share (e.g. contract for 4 SeaExplorer in March 2017 with DFO Canada). It also signed a major contract for the supply of syntactic foam blocks to Oceaneering for a groundbreaking project in the Gulf of Mexico. Finally, its detector made it possible to locate the black boxes of the Egyptair plane who crashed in the Eastern Mediterranean in May 2016.

The Seaexplorer, Deepexplorer and Ultradeepexplorer gliders are underwater unmanned vehicles with very long endurance, allowing them to remain at sea from 4 to 8 weeks. The second line of products is specifically for special naval forces: it includes underwater vehicles to transport combat swimmers and for ISR missions. The third line of products is specific to radio-communications antennas for navy vessels and submarines, and expendable radio-communications buoys launched from submarines. The fourth line of products is acoustic equipment: GIB acoustic systems are used to track underwater vehicles and torpedoes and to train crew. The DETECTOR is used to detect black boxes: ALSEAMAR successfully took part in locating plane crashes at sea, such as Egyptair flight MS804 (Mediterranean), the Sharm-El-Sheikh crash (Red Sea) and the Sochi crash (Black

Sea). The fifth line of products, sold under the BMTI brand name, includes ultra-deep water buoyancy materials. Its innovative syntactic foam formulations and closely controlled manufacturing processes have made ALSEAMAR a key industrial player.

Applied Acoustics

Great Yarmouth, Norfolk, UK
<http://www.appliedacoustics.com>

Applied Acoustics designs and manufactures high-tech subsea positioning transponders, USBL underwater tracking systems and sub-bottom profiling equipment. The company, founded in 1989, initially provided equipment to the offshore energy sector but, in addition, now supplies oceanographic institutions and defense industries that are all supported by a network of overseas distributors. The two product lines both use acoustic technology, that is the transmitting and receiving of soundwaves underwater, to either position equipment that cannot be detected visually under the sea, or to survey the uppermost sediment and rock layers of the seabed.

- The positioning equipment provides



Applied Acoustics

the GPS coordinates of stationary equipment placed on the seabed, or tracks the path of moving devices, or divers, used in subsea exploration, inspection or search missions.

- The seabed survey equipment builds a 2D profile, a picture of the geology beneath, that helps determine the best place for construction pilings for wind turbines for example, or the best routes to bury pipes or cables.

Aquatic

Aberdeen, Scotland, UK
<http://www.aquaticsubsea.com>

Aquatic Engineering & Construction Ltd., an Acteon company, is a leading independent service provider of carousels, modular drive systems and tensioner solutions for the global oil and gas, telecommunications and energy industries. Aquatic develops and leverages innovative technology and offers an extensive range of equipment for installing and spooling of flexible systems such as risers, flowlines, umbilicals, cables and mooring lines. The spectrum of services includes SURF knowledge, project management, offshore expertise, engineering, HSEQ and logistics. One of Aquatic's solutions for deep water installation operations came from a North Sea project requirement which required tensioners that could provide in excess of 50Te of holdback tension during deployment of an umbilical. Aquatic's in-house electrical, hydraulic and structural engineering teams designed an innovative solution to integrate and control two 50Te tensioners together in series to increase the overall hold back tension to 90Te.



Aquatic Engineering & Construction



DimEye

Calabasas, CA, USA

<http://www.dimeye.com>

Annual Sales: \$2,000,000.00

DimEye, founded in 2009, developed a new technology called VLS (Video Laser Scan). By processing HD video recorded from ROV, VLS allows high-accuracy 3D survey of any subsea structure. Accurate measurements that have never been done before are now possible, providing highly reliable information for Integrity Management of Assets and Modification Projects.

Focal Technologies, a Moog Inc. Company, specializes in providing electrical slip rings, fiber optic rotary joints, hydraulic utility swivels and fiber optic multiplexer solutions for the worldwide marine industry including ROV, seismic, FPSO turret and oceanographic applications. Product features include hybrid packages that combine fiber, electrical and fluid rotary joints for harsh environments, explosion proof/flameproof for hazardous locations and adaptation to customers' size and mounting constraints. Electrical Slip Rings are electromechanical devices that allow the transmission of power and electrical signals from a stationary to a rotating structure. A slip ring can be used in any electromechanical system that requires unrestrained, intermittent or continuous rotation while transmitting power and/or data. It can improve mechanical perfor-



Focal Technologies

mance, simplify system operation and eliminate damage-prone wires dangling from movable joints. Focal also designs, manufactures and delivers unique Floating Production System (FPS) swivels to meet the demanding requirements of offshore operators worldwide. FPS Swivels are used in a variety of Floating Production Systems including buoys, turret moorings and offshore loading towers. Focal Multiplexer products offer a range of time division multiplexers and wave division multiplexers. These multiplexing techniques can be used to simplify optical transmission systems and reduce cost, improve reliability, re-

DeepSea Power & Light, Inc.

San Diego, CA, USA

<http://deepsea.com>

DeepSea Power & Light was founded 34 years ago as a supplier of subsea batteries, lights, cameras, lasers, and pressure relief valves. Its product line has grown to include underwater video systems, lighting solutions, pressure relief valves, and lasers. Design criteria for products include ease of service, reliability, high performance, and cost effectiveness. Products are rigorously tested in both the initial design process and manufacturing stage to perform in the harsh marine environment—from wet/dry surface applications to full ocean depth deployments. DeepSea Power & Light offers a versatile product line while developing new designs to continue exceeding market expectations.

The Seacam cameras include HD and analog video outputs and zoom cameras. Common features include sapphire ports and wide angle optics. Many models are available in a titanium housing for long-term immersion and corrosion resistance, and select models have a full ocean depth rating option. Most SeaLite luminaires come with full dimming capabilities for a variety of subsea applications. A titanium housing and full ocean depth rating option are available on select models. The LED SeaLite offers Seasense Serial Protocol and Multiray: a compelling technology that enables a single luminaire to separately operate two LED and beam pattern configurations. Other products include the SeaBattery Power Module, a lead acid battery rated to full ocean depth; SeaLasers, available with line or dot outputs; and SeaVent pressure relief valves with adjustable cracking pressure and vacuum attachment options.



DeepSea Power & Light

duce weight and enhance performance. Fiber Optic Rotary Joints are a means to pass signals across rotating interfaces, particularly when transmitting large amounts of data. Ruggedized for harsh environments, compact sizes and a variety of custom configuration options. Fluid Rotary Unions are currently used around the world to ensure reliable transmission of life support, process, power and control fluids. Condition Monitoring solutions reduce operating costs using optical monitoring and slip ring sensors to enable preventative maintenance.

Liquid Robotics

Sunnyvale, CA, USA

<https://www.liquid-robotics.com>

Liquid Robotics makes the Wave Glider, an autonomous ocean surface robot used to enable long duration observation and monitoring. The Wave Glider enables real-time data collection and communications from the seafloor-to-space.

Liquid Robotics was born out of a passion for the ocean. In 2005, it set out with the simple goal of recording humpback whale songs off the coast of Hawaii. Founder Roger Hine went about design-

ing a system that could hold its position at sea—even if it wasn't anchored in place—and operate 24/7 without harming the environment. The result was the Wave Glider, a surface robot that is powered by wave and solar energy. The company has received many prestigious innovation awards. The most notable are: The World Economic Forum Technology Pioneer, The Economist Ocean Innovation Challenge Inaugural Winner, MTR Top 100 and the Guinness World Record for the "the longest journey of an autonomous, unmanned surface vehicle on the planet." In 2016, it joined The Boeing Company. The Wave Glider is composed of the float and a sub with wings. Connected by 8-meter tether, the float is on the surface of the ocean where conditions are the harshest with the sub below where it is calm. It converts the up and down motion of the waves into forward thrust. Solar energy powers the on-board computing, communications, navigation and sensor payloads.

Wave Glider advantages include:

- No dependency on fossil fuels,
- 24/7 long-duration operations,
- Station keeping for up to 12 months,
- Open & Extendable Platform: Add new sensors and software capabilities.



MRV Systems

MRV Systems

San Diego, CA, USA

<http://www.mrvsys.com>

MRV Systems provides profiling floats and autonomous underwater vehicles to make high-quality measurements of physical properties of the ocean. MRV products cover from the surface to 6,000m. Some are specially designed for ease of air deployment. All are designed to be low-cost and high-endurance, to enable efficient exploration of the oceans, particularly in areas where observations by traditional methods are not practical. MRV was founded in 2010, as a spin-off from the Scripps Institution of Oceanography, with a license to manufacture the SOLO II profiling float. Since then, MRV has refined the original SOLO II design to the MRV S2-A, and expanded its product line to include an 'A'-size profiling float, the Air Launched Autonomous Micro-Observer (ALAMO). MRV's flagship product is the S2-A, a refinement of the SOLO II design originally licensed from the Scripps Institution of Oceanography. The S2-A is a buoyancy-driven vertical profiler, capable of operating to 2,000m depth. It typically carries a Conductivity-Temperature-Depth sensor to obtain vertical profiles from 2,000m to near the surface. To meet the needs of more rigorous environmental deployment conditions, MRV developed, built, and deployed a smaller vertically profiling float. The ALAMO is an 'A'-sized air-deployable profiling float meant to provide the same performance as the MRV S2-A, but in a smaller package. The ALAMO has been successfully launched each year to date since the 2014 hurricane season.



Liquid Robotics



Nortek

Rud, Norway

<http://www.nortekgroup.com>

Nortek has focused on development of advanced Doppler instrumentation for 20 years. Nortek's instruments, processing power, and customer support give users the ability to do new things. Nortek designs, develops and produces scientific oceanographic instruments that are used to measure the movement of water in its different forms. These instruments are used by scientists, researchers and engineers at renowned institutions worldwide. They are deployed

in demanding environments that require state-of-the-art instrumentation that is reliable and easy to use. Nortek's Doppler Velocity Logs (DVL) are used for subsea navigation, and Nortek's innovative Acoustic Doppler Current Profilers (ADCP) are used to understand physical processes in the ocean, rivers, lakes and laboratories.

Oceanalpha Co., Ltd.

Zhuhai, Guangdong China

<http://www.oceanalpha.com>

Oceanalpha is a company focusing on USV (Unmanned Surface Vehicle) development and offering USV solutions for water environment sampling and monitoring, hydrographic survey, oceanographic survey, nuclear radiation monitoring and water surface cleaning, etc. With advanced intelligent technology and deep understanding of user working environment, Oceanalpha autonomous boat have already served clients from industrial company, gov-

ernment office, research institute and universities in world-wide. The latest Ocean USV Platform can be used for hydrology research, scientific exploration, hydrographic survey, emergency search and rescue, security patrol and other work on sea.

The boat size is 1.15 x 0.75 x 0.43m and weighs 26kg, making it easy to carry on the back of a SUV or truck. It has been widely used for routine water sampling and monitoring, emergency pollution accidents or research in complicated environment. The smallest model is of 128cm long and weighs about 9.8kg, making it one-man transportable.



HydroComp, Inc.

Durham, NH, USA

<http://www.hydrocompinc.com>

HydroComp, Inc. provides technical software for ship resistance and propulsion predictions, propeller sizing and propeller design. Its unique products and consulting services in the areas of forensic analysis, propulsion analysis and propeller design highlight our distinct capabilities in the global maritime community.

It was established in 1984 and is a source for applied hydrodynamic software tools and expert consulting services to marine professionals around the world. HydroComp products and services are used by designers and builders, owners and operators, academics, propulsion equipment suppliers, governments, and militaries worldwide from more than 60 countries. HydroComp is a pioneer in the very specific area of applied hydrodynamics. This focus shaped a line of unique naval architectural software packages beginning with our flagship product NavCad, and include SwiftCraft, PropExpert, PropCad and PropElements. More recently, it has released the premium versions of both NavCad and PropCad, significantly increasing their capabilities and addressing the needs for greater fuel efficiency, cost savings, and increasing productivity.



DonMacPherson

Ocean Sonics



Ocean Sonics Ltd.

Nova Scotia, Canada
<http://www.OceanSonics.com>

Ocean Sonics manufactures the icListen Smart Hydrophone, a passive acoustic monitoring system, combining smart electronics with high signal performance to give customers the best digital hydrophone technology. Creating digital hydrophone arrays is now simple. Connect two or more icListen Smart Hydrophones together and they self-synchronize, operating as one. Whether using internal hydrophone memory, or logging multi-channel data externally, users record multichannel array data. The Ocean Sonics approach offers a wide range of geometries, including vertical, horizontal, very small geometrical arrays or spread out over many kilometers.

Remote Ocean Systems

San Diego, CA, USA
<http://www.rosys.com>

For more than 40 years Remote Ocean Systems has been a leader in the development and manufacture of reliable,

latest technology camera, lighting and positioning systems for extreme oceanographic, industrial, commercial and military applications and environments. TOS headquarters and manufacturing facility is located in San Diego.

ROS is an ISO-9001-2008 certified company with a 28,000 square foot research and manufacturing facility. Its product line includes underwater video cameras, lights, rugged pan and tilt positioning systems, video inspection systems and control systems manufactured primarily for the oceanographic, nuclear and defense industries. ROS manufacturing is a cell-based operation, incorporating one-piece flow and 5S lean manufacturing environment.

Its headquarters and manufacturing facility houses a modern machine shop, hydro-static pressure test tanks, electronic labs, advanced computer modeling, prototyping systems and environmental test chambers.

RJE International

Irvine, CA, USA
<http://www.rjeint.com>

RJE International supplies acoustic marking and relocation systems, subsea vehicle and equipment moorings, diver navigation and sonar systems, underwater communications and small boat navigation for military and commercial divers worldwide. Its products boast a high level of quality and are designed for a rigorous subsea environment. Its end-of-run location mini-pingers were



RJE International

recently selected as the equipment of choice for the NUW Center in Keyport, Washington to support their underwater tracking operations. It continues to innovate new equipment, releasing the new and improved DPR-275/PRS-275, a diver pinger receiver and pinger receiver system that can track and locate any acoustic pinger operating between 5 to 80 Hz. It also unveiled the DG100 Digital Depth Gauge, which ensures diver safety by alarming them when they are exceeding their boundaries underwater. Alongside these recent additions, it is updating its VADR-6000M, an acoustic directional receiver that helps ROV and AUV operators track sources of sound, with improved software to extend its capabilities. RJE International specializes in customization to serve its wide variety of clients, and most of its equipment can be outfitted for a specific task.

Remote Ocean Systems



Kongsberg Maritime

Horten, Vestfold, Norway • <http://km.kongsberg.com>

Kongsberg Maritime's sonar, multibeam echo sounders, cameras, positioning and underwater communication systems, and AUVs are used in survey and inspection operations worldwide. Working closely with customers to develop technology that pushes the limits in subsea applications, Kongsberg Maritime is also dedicated to developing innovative environmental, digitalization and autonomy solutions.

Kongsberg Maritime is a marine technology company providing innovative solutions for all marine industry sectors including merchant, offshore, subsea, naval and fisheries. Kongsberg offers a new portfolio of Integrated Vessel Concepts and technologies for autonomous operation and digitalization above and below the water. The company offers expertise in all areas of operation from commercial survey, underwater intervention and naval operations through to marine science, fish farming and professional fishing.

Kongsberg develops cutting-edge hydroacoustic systems including multi-beam and single beam echo sounders and sonars, camera, positioning and subsea communication equipment, heading and motion sensing instruments, and sound velocity sensors and processing software. Other areas of

expertise include environmental monitoring and integrated technology for everything from autonomous ships to research vessels and fish farms. Kongsberg is the company behind the Seaglider, REMUS, HUGIN and MUNIN AUVs. It is also a key stakeholder in Eelume (see page 39), a unique new 'snake-like' robot for underwater inspection/maintenance. Recent subsea technology developments include two new underwater glider systems for the Seaglider portfolio. The company has taken a lead in technology for autonomous vessels and is primary technology partner on two new unmanned ship newbuilds. Kongsberg is also at the forefront of digitalization, with its new Kognifai digital platform designed to revolutionize the application of digital technology in diverse verticals from shipping and oil and gas through to training and all areas of subsea operations. The Kongsberg Mesotech Ltd subsidiary

is also leader in the underwater acoustic industry. Clariscan is a domed sonar for underwater vehicles and provides a significant improvement in resolution and usable operating range. The MS1000 High-Resolution Sonar System is used by search & recovery organizations worldwide, while PulSAR is a sophisticated high resolution side scan sonar.



Egil Haugsdal, CEO & President



Kongsberg Maritime

EdgeTech

W. Wareham, MA, USA
<http://www.edgetech.com/>

EdgeTech designs, manufactures, sells and supports underwater technology solutions including: side scan sonars, sub-bottom profilers, bathymetry systems, reliable USBL acoustic tracking and positioning systems, transponder beacons, deep sea acoustic releases, shallow water and long life acoustic releases, underwater acoustic command and control systems and custom-engineered acoustic products.

The company traces its history back to 1965 when it started out as a division of EG&G Marine Instruments. In 1995, EdgeTech became a private company and selected its name in part to honor the late Dr. Edgerton, an MIT professor, marine instrumentation pioneer and a founder of EG&G. In 2012 ORE Offshore, a leading provider of acoustic releases, transponders and USBL systems, adopted the EdgeTech name after over 10 years operating as an affiliate organi-



EdgeTech

zation within the company.

EdgeTech continues to provide cutting edge acoustic imaging products and acoustic command and control systems to the market. Recently a new 4125-SAR (Search and Recovery) system was introduced specifically for the police, fire and SAR dive teams that have shallow-water/ high-quality sonar requirements. For deeper waters customers, EdgeTech introduced the new 2300 Combined Tri-Frequency Side Sonar, Sub-bottom Profiling & Bathymetry System. The Acoustic Release, Actuated, Transponders and USBL product line has intro-

duced a number of new products with more to come this year.

EdgeTech now offers a communication interface to the University of Rhode Island Inverted Echo Sounder or "URI PIES" system through the EdgeTech 8011M deck box.

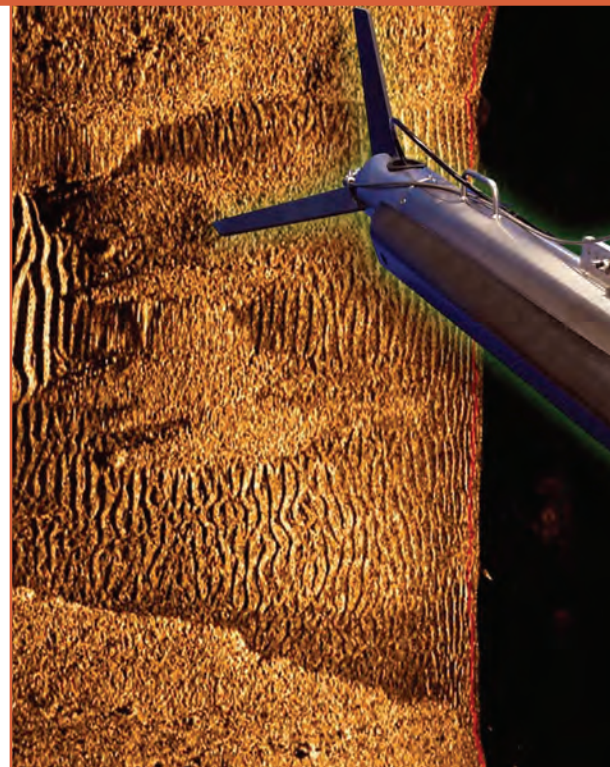
EdgeTech is also developing a thermally-activated release mechanism. The unit has been designed as a reusable OEM solution for researchers, scientists and other individuals that design and integrate underwater packages that require a simple and reliable release mechanism.

Falmouth Scientific, Inc.

Cataumet, MA, USA
<http://www.falmouth.com>

Innovation, systems knowledge, and field experience are the elements that drive the people at Falmouth Scientific, Inc (FSI) and the products it delivers. The systems that FSI develop help scientists, oceanographers, surveyors and others from varied industries collect the data they need to accomplish projects quickly and accurately.

FSI was founded in 1989 based on technology licenses for instrument designs from the Woods Hole Oceanographic Institution. Throughout the years it has expanded its portfolio to include sonar systems, sensors and a variety of underwater acoustic transducers. Strengths include electrical, mechanical, acoustic and system engineering as well as on-site production and test capabilities. FSI operates from a state-of-the-art facility located in the marine technology cluster on Cape Cod, MA. FSI's sensor based product areas include advanced sub-bottom and side-scan sonar imaging systems; current, wave and tide meters; acoustic transducer manufacturing and test; and acoustic positioning systems. Services include custom design, development, integration and production of marine technology and value-added services such as prototyping, product assembly, potting, calibration and pressure testing.



BIRNS, Inc.

Oxnard, CA, USA • <http://birns.com>

BIRNS, Inc. is an ISO 9001:2008 certified leader in the design and manufacturing of high performance connectors, custom cable assemblies and lighting systems. Since 1954, the company has helped shape the face of innovation in the sub-sea industry with technologically advanced solutions trusted in the planet's most demanding environments.

During its six decade history, BIRNS lights and connector systems have been trusted to provide support for the marine industry's highest profile projects: from Sealab and the Andria

Doria, to the search for flight MH370 and the Concordia salvage effort. Today, BIRNS products continue to provide illumination at greater depths, and faster, more robust communication options for extreme applications — from

diving bells, decompression chambers, and security uses to manned submersibles, ROVs, AUVs and UUVs worldwide.

BIRNS launched its connector division in 1990, which soon yielded the popular BIRNS Millennium series, a 6km-rated high density dry mate line. This series can be used with solid or oil-filled cables in straight or 90° configurations and is available in high and low voltage, coax, fiber-optic and hybrids of electro-coax, electro-optical and electro-opto-mechanical formats.

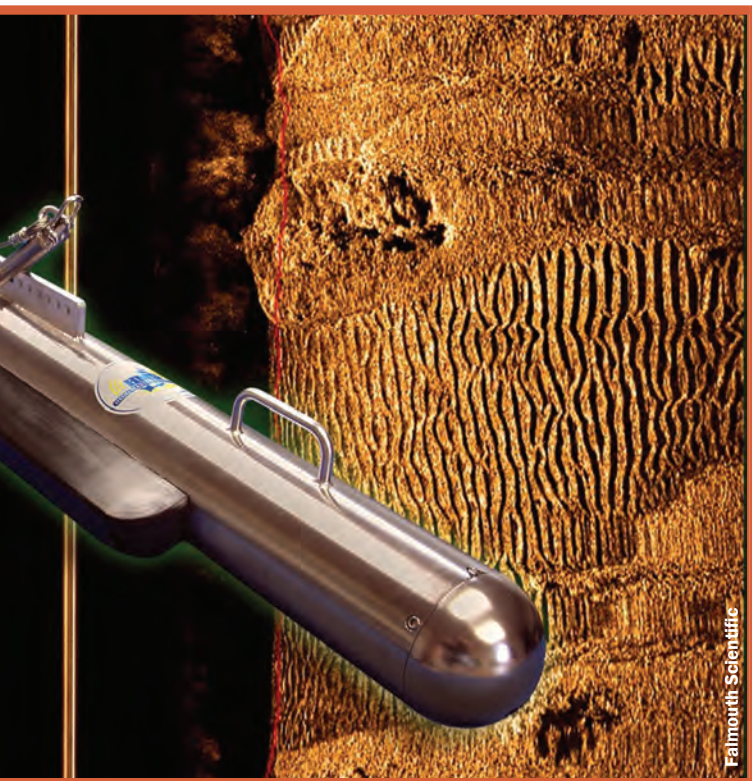
The company has been illuminating the depths with powerful, robust lighting systems for more than half a century, and in 2010 introduced innovative LED versions of lights for use in PVHO, helmet and vehicle applications. In 2013, BIRNS developed fiber optic penetrators to add to its liens of ABS PDA certified penetrators, which featured low insertion loss of < .2dB and high return loss of >35dB. Recently the company led the industry once again with the development of revolutionary new coax contacts for its BIRNS Millennium line with a maximum insertion loss of 0.7 dB at signal frequencies to 3GHz, with an associated maximum SWR (Standing Wave Ratio) of 1.7:1. These incredible new coax contacts withstand open face hydrostatic pressure, provide incredible ease of assembly and connect directly to a standard MIL-STD-348 SMA connector.

BIRNS has provided industry-leading testing capabilities for its own precision-engineered lighting and connector product lines, and serves as an independent testing resource for the industry. The company's custom-engineered hydrostatic pressure testing system has digital data recording capabilities and can be controlled remotely or via automatic programming. In it, technicians can simultaneously test three independent pressure circuits in six chambers at pressures up to 20,000 PSI (138 MPa), in fresh or salt water. BIRNS' electrical test system was custom-designed by Kikusui and permits the simultaneous testing of up to 16 electrical circuits, automatically, with up to 99 different programmable test sequences, at voltages up to 10kV, while subjected to hydrostatic/hydrodynamic pressure.

Eric Birns



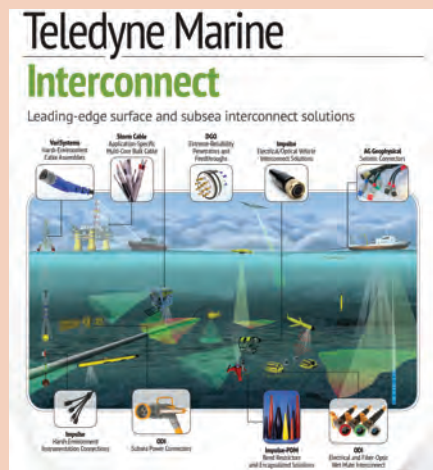
BIRNS



Teledyne Marine



Charting innovation across the Teledyne family of brands is a year-long coverage endeavor. MTR gives it best effort in context of the MTR100.



Teledyne Marine Interconnect

Teledyne Marine Interconnect integrates the resources of Teledyne AG Geophysical, ODI, DGO, Impulse and Cable Solutions, supplying electrical, optical and hybrid interconnect solutions for industries like offshore energy, defense and ocean science that rely on submersible connectors, penetrators, cable assemblies and terminations, and encapsulation and molding for connectivity in challenging conditions like deep water, extreme temperatures or high differential pressures. Teledyne Marine Interconnect can power subsea instruments or sensors, or transmit signals via Ethernet or fiber optics from three feet to three miles deep. Its capabilities include:

- Connectors: Range of standard or custom solutions from miniature dry-mate instrumentation connectors to sub-sea power and fiber optic wet mateable connectors
- Cable/pressure balanced oil-filled assemblies: Electrical, optical and mechanical assemblies designed and manufactured using various materials and molding techniques
- Hull penetrators and feedthrough systems: Electrical and optical interconnect for high differential pressures or



extreme temperatures found in manned or unmanned subsea vehicles and down-hole well applications

- Encapsulation/molding: Design and development of complex encapsulation/molding solutions for subsea components
- High-performance cables: Custom-engineered, application-specific multi-core electrical and optical solutions

The Interconnect group recently launched a series of “Active Flying Lead” products that allows more flexibility in existing or new subsea power and data networks. The technology consists of a compact housing integrated into a pressure-balanced cable with wet-mate connectors on both ends of the assembly. The housing can accommodate a variety of customer-specified electronics that can be used to lengthen distances between subsea nodes or instrument platforms, reduce the need for additional routing modules or convert media signals for additional equipment capability or system upgrades.

Teledyne Marine Imaging

Teledyne Marine Imaging group develop and manufacture acoustic and digital imaging systems ranging from high-resolution underwater cameras to

advanced sonar technology. The group offers a product portfolio for subsea imaging and multibeam echosounder solutions in a variety of application areas including offshore, hydrography, civil engineering and dredging as well as defense and security.

Its Engineering Services department has more than 40 engineers and hydrographic surveyors focused on providing customer support, with six worldwide operating service centers and a global network of service partners. Specific to underwater cameras and LED lighting, Teledyne Marine Imaging provides through-life support and can provide vision or lighting solutions for almost every subsea and offshore requirement via standard or combined systems.

In the multibeam echosounder market, customers often expect constant functionality and cost efficiency improvements, especially in the defense sector where demand for mature, ruggedized solutions are driving new technology and solutions for forward looking imaging sonars, software solutions to support operations.

Another existing growth area is occurring around infrastructure monitoring and repair works of marine constructions, inland waters and harbors, and here the combined solution offering between Teledyne BlueView, RESON, Odom and Bowtech are suited to solve challenges in this field.

Teledyne BlueView launched several new products around the 2D forward looking and 3D scanning sonar product lines, particularly the 360° profiling sonar, T2250 capable of gathering over 45,000 range measurements per second. It is a turnkey system with onboard data logging and real-time collection and visualization capabilities through Teledyne PDS software, ideal for 3D profiling inside tunnels from 2m to 16m di-

Leading-edge surface and subsea sensors for every application



Teledyne RESON introduced four new multibeam sonar systems: the Integrated Dual Head SeaBat T20-R & T50-R and the modular SeaBat T20-R & T50-R Multibeam Sonars.

These multibeam sonars are built on the SeaBat T-series platform which delivers excellent data quality, enhanced sonar capabilities and a selection of sonar processors including the new Rack Mount processor.

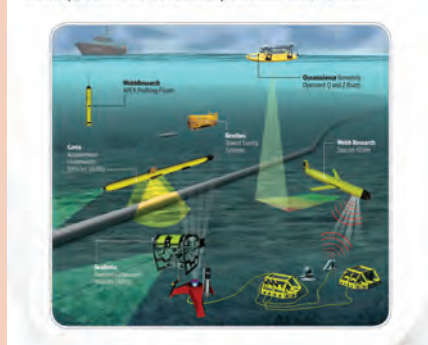
Teledyne Bowtech added two new products to the range of HD underwater cameras: the L3C-AHD is built upon the L3C-HD but provides an analog signal option, and the Sea Knight digital still camera is one of the smallest in its class, providing 13MP photos and 16GB of storage space – with high photo quality.

The new LED-B-Series, designed for use on small ROVs, sees ultra-small form factor meet high productivity. It delivers up to 1,500 lumens, is power efficient and is suitable as a replacement for larger lamps with similar outputs on-board bigger vehicles.

The Teledyne Marine Instruments brands Benthos, CDL Systems and Solutions, Cormon, Oceanscience, RD Instruments and TSS manufacture sub-sea and surface sensors used for offshore energy, oceanographic, defense/

www.marinetechologynews.com

Proven performance and reliability from surface to seafloor



security, hydrographic and aquaculture applications. Collectively, the Instruments group designs and manufactures hundreds of sensors that enable exploration, study and effective utilization of the oceans and inland waterways. Core technologies include:

- **Acoustic Communications:** Benthos acoustic modems for wireless subsea communications at up to 6,000m depth and up to 6km range
- **Acoustic Releases:** Benthos acoustic releases for the recovery of coastal to deep water instrumentation moorings
- **Corrosion Monitoring:** Common subsea and surface corrosion and erosion sensors and flow monitoring systems for subsea, surface and land-based applications
- **CTDs and Underway Profilers:** RD Instruments standalone CTDs and Oceanscience underway profiling systems for on-the-fly sound velocity measurements
- **Current Profiling:** RD Instruments Acoustic Doppler Current Profilers (ADCPs) for measurement of full column currents and waves in environments ranging from shallow streams to deep water moorings
- **Pipe and Cable Tracking:** TSS pipe trackers for pipe and cable detection and tracking from ROVs
- **River & Stream Monitoring:** Oceanscience tethered and remotely

operated surface platforms for efficient
inland ADCP surveys

- Subsea and Surface Navigation: RD Instruments Doppler Velocity Logs (DVLs) for precision subsea navigation onboard manned and unmanned vehicles; and TSS Gyros, Inertial Navigation Systems (INS) and motion sensors for precision surface and subsea navigation, offshore positioning and motion compensation
- Subsea Tracking and Positioning: Benthos USBL system for shallow water tracking, plus a full line of underwater pingers, transponders and tracking devices

In 2017 Teledyne Marine Instruments introduced 10 new technologies spanning every brand within the group:

- Teledyne Benthos: Shallow-water technology including the Releaseit Deck Unit and R500 acoustic release for operation in up to 500m of water, and the new Trackit USBL system for shallow water tracking applications
- Teledyne Cormon: The CEION2 and DCU4 provide rapid response, on-line or offline corrosion monitoring from multiple sensors on the same network
- Teledyne Oceanscience: Q-1250 portable remotely operated boat for inland ADCP surveys, now compatible with StreamPro, RiverRay and RiverPro RDI ADCPs

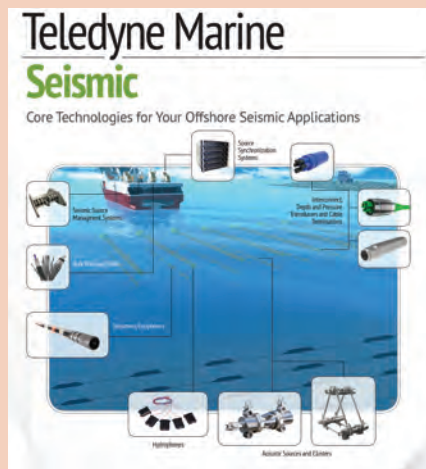
- Teledyne RDI: Ultra-compact Pathfinder DVL, as well as added real-time data and bottom tracking capability for the Sentinel V ADCP product line
- Teledyne TSS/CDL: Compact 660 Pipe Tracker enabling smaller electrical vehicles to perform pipe and cable detecting tasks that previously required work class ROVs; as well as new additions to the Saturn family, including the Saturn DVL and Saturn INS with additional technologies to follow

Teledyne Marine Vehicles

Teledyne Marine manufactures a wide range of unmanned vehicles for operational from the water's surface to the seafloor. Teledyne is a one-stop supplier of surface, shallow, mid and deep water unmanned vehicles and towed systems, addressing various applications for oceanographic research, offshore oil and gas, and defense and security. The Vehicles group includes Benthos, Gavia, Oceanscience, SeaBotix and Webb Research.

The Oceanscience unmanned surface vehicles provide remote survey and water measurements on rivers, inland waterways and shallow coastal areas. The Webb Research Slocum glider earned its reputation at sea as a reliable and versatile underwater glider, with over 650 units delivered since 2002 and the Teledyne Webb Research APEX floats make up nearly two thirds of the floats in the ARGO program. The Gavia Offshore Surveyor AUV is a low logistics vehicle for the commercial survey market. Gavia's modular design and small footprint make it easily deployable from a vessel of opportunity and quickly reconfigurable to meet changing mission requirements. SeaBotix ROVs, known for their reliable operation and small footprint, are used by the Explosive Ordnance Disposal (EOD) units of the U.S. Navy for a number of tasks that help keep military personnel out of harm's way. Benthos manufactures a group of towed survey systems, including the Deep Tow for survey and search and recovery tasks at depths up to 6,000m.

This year Teledyne Webb Research



launched the new G3 Slocum glider, offering better options for piloting, energy management and ballasting along with other improvements for long duration water column monitoring. Teledyne Gavia released three new modules for the Gavia AUV; the Science Bay, which is a generic payload module that allows a user to add up to six scientific sensors, a new side scan/ bathymetry sonar module and a new battery module with increased energy to extend mission duration. Teledyne SeaBotix has improved its Smartflight Semi-Autonomous Navigation package with the release of Smartflight 2.0, powered by Greensea and the integration of the new RD Instruments PathFinder DVL. This package offers improved low altitude hovering performance, station keeping, waypoint navigation and return to target autonomous functionality. It also provides visual integration of multiple sensors including Teledyne BlueView sonars, Teledyne Benthos USBL tracking capabilities and other third party sensors. For surface operations, Teledyne Oceanscience released its new Q-boat 1250, designed specifically for shallow water applications as a one-man portable remote vehicle that is easy to set up and operate, and accepts most industry standard ADCPs.

Teledyne Marine Seismic

Through organic growth and acquisitions, Teledyne Marine has amassed a series of core technologies and expertise to address the needs of the seismic industry. The group designs and manu-

factures seismic sensor and sensor arrays for subsurface geological structure mapping, identifying features likely to contain hydrocarbon deposits under land and sea, and surveying below the ocean floor to facilitate pipe laying and structure placement.

The Seismic group within Teledyne Marine supplies seismic survey fleets with submersible connectors, streamers, energy sources, source management systems and complex hydrophone systems for geophysical surveys and other marine market applications. Contributions from Teledyne Marine connector suppliers add capabilities for subsea electrical and optical connectivity to create life of field seismic or ocean bottom seismic systems for continuous monitoring in harsh underwater environments.

Bolt's Seismic Acoustic Sources provide compression wave technology for subsea geophysical strata analysis. Real Time Systems (RTS) specializes in the design and manufacture of controllers and synchronizers to manage the timing of the sources and records all of the quality control functions for later analysis. Geophysical hydrophone arrays record the acoustic source sound wave returns. AG Geophysical, ODI, Cable Solutions and Impulse offer cables and connector components.

The Teledyne Marine Seismic group operates facilities located in the Houston region and a European support facility, all with advanced machining, manufacturing and testing capabilities. Manufacturing and support areas include purpose-built streamer assembly and repair facilities, pressure vessels for hydrostatic testing, acoustic test facilities and in-house machining and tooling. Teledyne Bolt recently developed an acoustic sound source that minimizes the noise pollution in the frequency range used by marine life, making it less intrusive to nearby mammals and pinnipeds. By optimizing the airgun's output, eSource limits unwanted high-frequency energy believed to be disturb marine life while retaining low-frequency output to conduct seismic surveys.

Forum Energy Technologies

Houston, TX, USA • <http://www.f-e-t.com>

Forum Energy Technologies, Inc. is a leader in the supply of ROVs, technology, tooling and software to the subsea sector. Over the past year the firm has developed and provided equipment to support survey, marine construction work, salvage work, offshore wind farm and educational projects as well as its core oil and gas and energy market.

Forum Energy Technologies, Inc. is a global oilfield products company, serving the drilling, subsea, completion, production and infrastructure sectors of the oil and natural gas industry. The company's products include highly engineered capital equipment as well as products that are consumed in the drilling, well construction, production and transportation of oil and natural gas. Forum is headquartered in Houston, with manufacturing and distribution facilities strategically located around the globe. Its subsea technologies include an extensive range of ROVs, rugged vehicles used by the subsea industry for trenching, electronic observation, hydraulic work and submarine rescue. It also provides a full range of tethering, tooling, robotic components and launch and recovery systems. Its thrusters, tether management systems and buoyancy foam are used by other ROV manufacturers.

Forum specializes in developing technology from its bases worldwide to benefit the energy sector with a strong focus on subsea work.

Eleven separate divisions combine to provide its comprehensive service offering. The company's legacy brands represent some of the best known in the business. The most recognizable include Perry and Sub-Atlantic (ROVs); B + V Oil Tools, P-Quip, Pipe Wranglers and Vanoil (tubular handling); Dynacon (LARS and winches); and Davis-Lynch, Cannon and Merrimac (downhole products).

Included in its subsea technology portfolio with 11 business lines are our ROVs; such as the Sub-Atlantic Comanche and Mojave electric observation class vehicles and its Perry XLX-C and XLX 200HP work class systems. Forum has also recently released version 11 of its VisualSoft software product suite which is widely used during survey and inspection of subsea assets, in particular pipelines and cables. In addition, Forum Subsea Rentals, offers subsea equipment for the global rental market. FSR currently operates out of three locations in Aberdeen, Houston and Singapore offering a full range of OEM rental products to all ROV and survey offshore projects. Having acquired MacArtney's EMO range, the company can provide DOMINO-7 Mk II and NANO-MUX multiplexers in response to a growing demand for compact, lightweight designs which deliver enhanced operational efficiencies while supporting a complex array of subsea sensors.



Prady Iyyanki, CEO & President

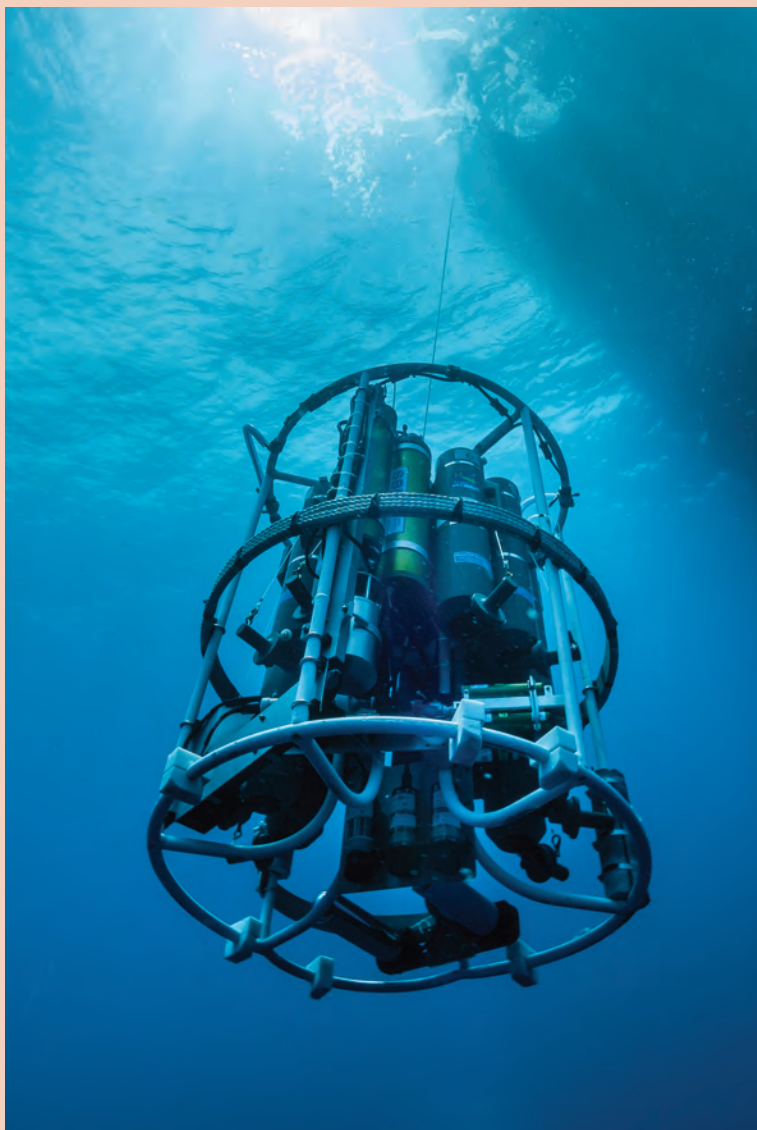


Sea-Bird Scientific

Bellevue, WA, USA • www.seabird.com

Sea-Bird Scientific combines the capabilities of Sea-Bird Electronics, WET Labs and Satlantic to provide sensors and systems for oceanographic research and environmental water quality monitoring of physical and biogeochemical properties. Sea-Bird Scientific employs more than 200 people in the U.S., Canada, Europe, China and India in the development, manufacture, calibration, sales, and support of its products. Every Sea-Bird instrument is delivered fully calibrated to enable the world's best science. It features 28 CTD and DO calibration baths at its U.S. factory, as well as a European calibration lab. Today, these automated calibration systems perform a combined total of over 40,000 complete sensor calibrations per year.

Sea-Bird Scientific has an extensive internal science team, with a number of Ph.D. oceanographers spanning several focus areas to determine scientific requirements for instruments, test and evaluate prototypes, oversee production calibration processes, and answer questions from scientists using instruments around the world. Key oceanographic parameters measured by Sea-Bird instruments include temperature, salinity, pressure, oxygen, pH, fluorescence, turbidity, nitrate, phosphate and irradiance. Its instruments are used on shipboard profiling systems, moored platforms, autonomous floats and moored profilers. Sea-Bird Scientific also manufactures several platforms for integration with sensors, including autonomous profiling floats and moored profilers. Advances in autonomous profiling float technology now provide reliable, stable temperature, conductivity and pressure measurements for five years and beyond. This, in large part, has been enabled by the Sea-Bird Scientific SBE 41 CTD sensor head, which is the standard for temperature and conductivity measurements for the Argo program. The Sea-Bird Scientific Navis Autonomous Profiling Float is used in the Argo and other ocean monitoring programs such as SOCCOM, with sufficient power for over 300 profiles with the SBE 41 CTD. The SOCCOM project is augmenting conventional Argo floats with biogeochemical sensors to measure carbon (pH), nutrients (nitrate) and oxygen.



Sea-Bird Scientific

Teledyne CARIS

Fredericton, NB, Canada
<http://caris.com/>

For over 35 years, Teledyne CARIS has been making software designed for the marine GIS community. In addition to product, Teledyne CARIS offers a comprehensive level of support through training sessions and consulting, online technical support, email, and multilingual telephone support.

Developed in cooperation with hydrographic clients and universities, the CARIS toolset provides clients with resource optimization and a true opera-

tional advantage. Known for the Ping-to-Chart solution, we offer a comprehensive portfolio of products, from the processing of the echo-sounder ping to the production and distribution of the chart. The newest product in the toolset, CARIS Onboard, is a near real-time and autonomous data processing package which has been developed with autonomous underwater vehicles (AUVs) and unmanned surface vehicles (USVs) in mind. This solution acts as a force multiplier when used on survey vessels by fitting seamlessly into the Ping-to-Chart suite of software, and reducing the overall product creation timeline.

Seafloor Systems

Shingle Springs, CA, USA

<http://www.seaflorsystems.com>

Seafloor Systems provides a full spec-



trum of hydrographic survey equipment, software, personnel, training and support, specializing in the geophysical sector for survey companies worldwide. It has designed and manufactured the HydroLite portable hydrographic survey system, the HyDrone-ASV and EchoBoat-ASV autonomously and remotely controlled survey platforms for unmanned hydrographic survey applications. Formed in 1999, by veteran U.S. Navy Hydrographer John Tamplin, it maintains the largest rental pool of multibeam echosounder equipment in the U.S.



Blueye Robotics

Trondheim, Norway • www.blueyerobotics.com

Trondheim-based technology firm Blueye Robotics AS launched Blueye Pioneer, a low-cost remotely operated underwater vehicle (ROV) – Blueye calls it a “drone” – that is designed to be very simple to operate and share video and images, or store data for documenting findings for mapping or monitoring.

Considering its portability, price tag and ease of use, the vehicle’s potential is manifest, providing “eyes under the water” for fish farmers, divers, environmental researchers and recreational users alike.

Blueye Pioneer’s developers foresee vessel hulls inspections as another application for which the underwater drone will excel, allowing ship owners, vessel crew and shipyards to examine below the surface in a safer and more cost efficient manner. Each Blueye Pioneer is priced around \$4,000-5,000.

The inspecting drone transmits video via an umbilical cable to the surface and thereafter wirelessly to the user onboard or onshore. It can be used, for example, to check the vessel’s structural integrity, inlets and discharge valves, rudder, propeller, coating levels and possible corrosion, or even check for explosives and smuggling of contraband.

Blueye has made it possible to control the Pioneer easily using a smartphone, tablet or goggles and the Blueye App. Dives can be shared live via direct connection to video streaming or online services and social media.

The Pioneer has been developed and tested in rough condi-



Blueye Robotics



Sensor Technology Ltd.

Collingwood, ON, Canada
<http://sensortechcanada.com>

In the last year Sensor Technology introduced two piezoelectric ceramics formulated to match the performance of Channel 5400 and 5800 (these two popular materials were withdrawn from the market), developed a number of hydrophones specifically for ocean bottom seismic nodes and upgraded its Quality Management System to ISO 9001:2015.

Many know Sensor Technology Ltd. as a manufacturer of custom hydrophones and acoustic/ultrasonic transducers. Others are familiar with Sensor Technology as a piezoelectric ceramics vendor. The company actually does both, from a single facility in Ontario, Canada.

The company commonly develops custom transducers for the oil and gas, fisheries, general marine and defense industries. Applications range from mine hunting and sub-bottom imaging to trawl monitoring and marine seismic exploration. Outside of the marine environment the company has designed custom hydrophones for applications such as medical imaging, oil well logging and gas flow measurement. Taking a custom transducer from concept, to prototype, to production, requires a flexible manufacturing facility. SensorTech can produce prototypes and small qualifying batches. At the same time, the company is capable of ramping up to large production quantities. Hydrophone output has been as high as 6,000 units per week. To date, SensorTech has shipped more than 1 million hydrophones.

InterMoor

Houston, TX USA
<http://www.intermoor.com>

InterMoor, an Acteon company, is a mooring, foundations and subsea services provider delivering solutions for rig moves, mooring services and offshore installation projects. It supports operators and contractors worldwide with its engineering, fabrication, shore base, survey and positioning and inspection services to provide customized solutions. For operators and contractors who require rig moves or who need to anchor FPU's, MODU's, TAD's, barges and other floating structures, InterMoor's mooring services provide an integrated solution that focuses on reducing cost, time and risk. InterMoor engineers actively participate in the planning, engineering, logistics, installation, and recovery operations for the vast majority of its mooring projects. Consequently, its knowledge of installation equipment, vessels and offshore methods allows InterMoor to offer the expertise needed to realize safe and efficient installation jobs. InterMoor also extends its oil and gas expertise to aquaculture and renewable projects such as floating wind and marine energy converters.



InterMoor



ASV Global

ASV Global

Portchester, Hampshire, U.K.
<https://www.asvglobal.com/>

Having delivered more than 80 autonomous systems, ASV Global maintains a leading position in the growing market for Autonomous Surface Vessel technology. The company's expertise combining platform manufacturing and control system development brings the latest in maritime autonomous technology to market. ASV Global platforms are in operation across the globe within a variety of industries.

ASV Global vehicles and control systems are designed, built, fitted and tested from the company's facilities in Portsmouth, U.K. and Louisiana, U.S.

ASV Global have operated vessels in Europe, U.S., Asia, Australia and Africa. A recent application of ASV technology includes an 11-day mission off the north coast of Scotland. ASV Global operated an autonomous catamaran collecting marine scientific data from its Mission Control facility in Portchester using satellite communication links. The autonomous vessel dubbed Thomas was monitored round the clock by the company's expert team of remote operators using live data feedback from the ASView control system as well as the onboard cameras and sensors. In other instances ASV Global technology has been used to compliment traditional methods of working at sea instead of replacing them. As part of a mission for a survey company, the ASV Global C-Worker 5 autonomous vessel was used for seabed mapping. Using the C-Worker 5 in parallel to the traditional survey vessel doubled the survey coverage saving 25 days at sea – a huge cost saving.

Schmidt Ocean Institute

Palo Alto, CA, USA • <http://www.schmidtocean.org>

Schmidt Ocean Institute is an international facility operator, now celebrating five years of cutting-edge research that is impacting and accelerating the pace of ocean technology development. Its philosophy of Open Data and knowledge-sharing leads to all information gathered and scientific results being made available online once processed.

Schmidt Ocean Institute believes that the latest technology is best shared and its research expeditions return unprecedented amounts of open-access data. As the Earth's oceans are critically endangered and one of the least understood parts of the environment, the Institute dedicates its efforts to using technology to advance science across an intentionally broad scope of research objectives. In order to promote a comprehensive understanding across oceanographic disciplines, it has hosted more than 465 scientists since 2012, representing nearly 138 institutions from 27 countries. It focuses on supporting projects that advance technology and surpass conventional data collection methods. Marine robotics, high performance computing, and live streaming of Remotely Operated Vehicle dives are just some of the ways SOI openly shares data in real time – this year alone, more than 65 ROV dives were broadcast live over the internet from SOI's global research platform, research vessel Falkor. Other unique outreach projects that reach a worldwide audience include SOI's Artist-at-Sea and Student Opportunities programs, both of which bring non-traditional specialists on board to inspire scientific understand-

ing and encourage exploration of the oceans.

SOI's mission to accelerate the understanding of the oceans through advancing technology has led to five years of cutting-edge research. Supporting multidisciplinary research collaborations in remote and isolated parts of the ocean, we target the technological, operational, and analytical gaps between traditional oceanographic approaches. This approach has been successful and led to a host of wide-ranging breakthrough innovations demonstrated on Falkor in 2016. For example, the use of proteomics, analysis of organisms' protein biomarkers, was utilized during a study by **Dr. Mak Saito** on how hypoxia in oxygen minimum zones influences microbial growth and functions.

Later in the year, **Dr. Tom Kwasnitchka** and his science team on Falkor imaged an entire active hydrothermal vent field with an ROV, reconstructing the data into a digital 3D model with sub-centimeter resolution. This digital model offers a holistic view of these unique deep sea ecosystems, as well as enables their exploration and analysis in Virtual Reality. Another ground-breaking expedition with **Dr. Oliver Wurl** and an international research team aboard Falkor investigated the biological, chemical, microbial, and physical processes regulating heat and gas exchange through the air-sea boundary. For the first time, scientific sea surface surveys were performed with a ship-deployed long endurance vertical take-off and landing (VTOL) robotic aircraft.



Schmidt Ocean Institute

LinkQuest Inc.

San Diego, CA, USA

<http://www.link-quest.com>

LinkQuest Inc. is a manufacturer of precision acoustic instruments. It manufactures precision acoustic instruments for offshore oil exploration, construction, drilling, survey, environmental study and other oceanographic applications. The company's acoustic communication and positioning products are based on the Broadband Acoustic Spread Spectrum (BASS) Technology. LinkQuest's high speed underwater acoustic modems transport more than 95% of the world's acoustic communication data. These systems have set a series of technical performance records in field deployments all over the world. LinkQuest's line of TrackLink Acoustic Tracking Systems provide highly robust, accurate and cost-effective UL-



LinkQuest

tra Short Baseline (USBL) solutions. The FlowQuest Acoustic Current Profilers, FlowScout Acoustic Flow Meters and NavQuest Doppler Velocity Logs (DVL) were designed to provide solutions for current profiling, wave measurement, flow measurement or precision underwater navigation applications.

MacArtney Underwater Technology GroupEsbjerg, Denmark • info@macartney.com

The cornerstones of the MacArtney fields of operation are:

- **Defense:** supplying connectivity products, instrumentation, deck- and-over-the-side handling equipment
- **Renewable Energy:** supplying solutions to wave, tidal and offshore wind
- **Civil Engineering:** providing underwater technology products and solutions to a wide range and variety of projects, operators and developers
- **Ocean Science:** handling scientific equipment and data, instrumentation applications and projects
- **Oil and Gas:** solutions from seabed to surface, supplying to the entire value chain
- **Fishery:** custom designed and engineered systems tailored to accommodate advanced specifications made by fishery customers

The MacArtney Group offers an extensive variety of advanced and reliable products and system solutions which are designed and tested to supply high quality, efficiency and dependable performance in challenging underwater environments. All MacArtney systems and components are backed by an international network of subsidiaries and representatives providing local access to global support.

MacArtney has been supplying products and engineering solutions for almost 40 years and is a privately owned corporation with group headquarters in Esbjerg on the west coast of Denmark. The MacArtney Group supplies and services a wide range of integrated systems and products designed, developed and manufactured by MacArtney. It is also representatives of leading manufacturers of underwater products.

MacArtney supply includes SubConn, OptoLink, TrustLink and GreenLink connectivity, cable and termination solutions, NEXUS and EMO fiber optic telemetry systems and LOTUS telemetry buoy systems. The MacArtney portfolio of handling equipment includes the electrically driven CORMAC and MERMAC winches, handling and LARS systems and the new CEMAC offshore cable lay handling equipment. The renowned MacArtney Active Heave Compensation (AHC) solutions are available for both the MERMAC winches, gangways, platforms and cranes. The MacArtney range of remotely operated towed vehicles (ROTV) includes the MacArtney FOCUS 2, FOCUS 3, TRIAXUS and FLEXUS vehicles. Moreover, MacArtney supplies a range of the versatile LUXUS underwater cameras, lights, media controllers, pan-and-tilt units and accessories.



MacArtney

CEMAC offshore cable handling equipment including linear cable engines, power quadrants, cable carousels and track tensioners, developed and manufactured by MacArtney

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Aquabotix

Fall River, MA USA

<http://www.aquabotix.com>

Aquabotix offers inspection class ROVs using IoT to produce what it calls the world's only digital inspection-class ROV platform. Aquabotix ROVs include Live Remote Viewing, a new product feature that enables real-time underwater connectivity between Aquabotix's products and remote customers via the cloud. Its portfolio of products includes ROVs, ROVs/AUVs and underwater camera systems. From case to water in three minutes; from inexperienced to accomplished pilot in three hours; no lengthy instruction, formal training or special degree is required to benefit from Aquabotix technology.

The Aquabotix Endura (pictured above) is the latest evolution in Aquabotix's history of ROVs. Endura is easy to use, portable (everything fits into one carry case), and can be customized with a variety of sensors to complete your mission whether simple or complex. Endura is small in size, but powerful in execution, with five knots of thrust and a sturdy hydrodynamic design. The AquaLens Connect is an underwater camera system designed to capture high quality underwater video and still images at the click of a button. It captures full 1080p

HD video and transfers a live feed to the surface on the user's iPad or laptop computer. AquaLens Connect can be used individually or with multiple units and can be combined into a network of underwater cameras, all controlled and viewed on one screen through Aquabotix's proprietary operating system.

Aquatica Submarines

West Vancouver, BC, Canada

<http://www.aquaticasubmarines.com>

Aquatica designs, manufactures and operates submersibles enabling underwater professionals, ocean stakeholders and visitors face-to-face access and intervention in the world's oceans. Products now complete or under design include:

a) Stingray 500 and 1000, both three-person observation submersibles rated to 500 and 1000 ft. respectively.

b) Stingray X, a three-person, com-



Aquatica Submarine

bined observation/light work class submersible rated to 3,300 ft. (1000m).

c) Swordfish 2500 and 5000, a two-person work class submersible rated to 2,500 and 5,000 ft. respectively.

d) The Seahorse Coastal Support Vessel and Mother Ship.

e) Subsea Tooling and Fabrication services.

f) Submersible Wet Leasing and Operational support services.

Blue Ocean Monitoring

Western Australia, Australia

<http://www.blueoceanmonitoring.com>

Blue Ocean is a data service provider, specializing in the deployment of long duration autonomous survey platforms. It is an independently run private company headquartered in Western Australia, and has gone from a three-person start up in 2014 to a multinational entity with five regional offices in four countries employing 20 people. It says it is the world's largest commercial owner and operator of the Slocum glider platform, but it aims to diversify to include autonomous surface vehicles and miniAUV subsurface technology. Blue Ocean has integrated, tested and now operate a number of customized sensor packages, including:

- 1. Acoustic** Seismic, construction, marine fauna
- 2. Biogeochemical** Seep detection, leak monitoring, oil spill response
- 3. Environmental** Baseline studies, pollution management, compliance monitoring
- 4. Visual** Habitat monitoring, seafloor classification
- 5. Data Harvesting** Infrastructure monitoring, deep water monitoring.



Blue Ocean Monitoring

Global Ocean Design LLC

San Diego, CA, USA

<http://www.globaloceandesign.com>

Global Ocean Design LLC is pioneering a new class of commercial undersea vehicle: the benthic lander, along with the component technologies and surface support systems that make these craft more cost-effective, user-friendly and reliable. Global Ocean Design was formed in 2011 in the quest to reach the Marianna Trench as a subcontractor to James Cameron's DEEP-SEA CHALLENGE Expedition. The company brought a legacy of techniques and experience from a globe-spanning 40-year career at the Scripps Institution of Oceanography/UCSD by its founder, Kevin Hardy. The small company was successful in the great endeavor. Still, the larger dream was to make access to the sea more affordable and simpler for researchers from all universities, agencies and NGOs. In 2011, Hardy proposed a plan to the International SeaKeepers Society (ISKS) to provide their vessels as "ships-of-opportunity" to global marine scientists who could use them to further their research using the tools of their discipline. The ISKS Discovery

Yacht program was the result. Its products find use in diverse installed customer bases, enhance other manufacturers' products, and provide standard free-vehicle solutions for a growing global community with its Nanolander fleet.

The Nanolander is a self-contained untethered, autonomous unmanned vehicle using 10-in., 13-in. or 17-in. buoyancy spheres for long duration benthic and mid-water operation using third party sensors. Nanolanders may be deployed without use of winch, crane or A-frame. Depth ratings of different models range from 1km-12km. Anchors are sourced in the port of operation, saving money on shipping. Its Beacon Board is new idea in surface location devices for sphere housings. Using a pair of GPS receivers linked by a VHF radio, the system provides the ship with an unambiguous, direct range-and-bearing to a surface target, up to 8 nautical miles of the ship, rain or fog. The Deck Purge Box (DPB) dynamically removes damaging moisture vapor from undersea housings of every kind prior to deployment. When the purge cycle is done, the user is ready to deploy. Its 10-in. OD polystyrene spheres have an O-ring seal and four connector ports. They work to 1,000m, making it a



Global Ocean Design

Cellula Robotics

Burnaby, BC, Canada

<http://www.cellula.com>

Eric Jackson, CEO/President

Cellula Robotics is an engineering solutions company specializing in the turnkey design and production of seafloor intervention and subsea robotic systems. Cellula's products are primarily used for geotechnical and geophysical applications around the world. Through its team of engineers, designers and technicians based on the west coast of Canada, Cellula has developed experience in projects that require integrated mechanical, electrical, hydraulic, and software elements in a sub-sea environment. Since 2001, Cellula Robotics has been assembling a diverse group of engineers and technicians capable of solving the unique problems of working subsea. Though the company began by designing subsea components for client-built vehicles, Cellula has since expanded to incorporate the design, assembly and testing of entire vehicles. In the last four years Cellula has built several state of the art seafloor drills and has expanded into the scientific research sector through its work on the Cetor3000, an environmental sampler used to collect and preserve microscopic samples, as well as an ROV suction sampler capable of collecting larger samples. Its component line ranges from subsea pressure tolerant electronics, valve packs and water and ground fault detection boards to the full-scale subsea machinery: excavators, drills and environmental samplers.



Cellula Robotics

low-cost pressure-proof housing with 11-lbs of buoyancy (empty). The plastic spheres will not corrode in seawater, are electrically inert, and invisible to WiFi and other RF. The LiPo Battery Pod provides 16vdc fully charged, 32Ah capacity, with a net buoyancy +4-lbs. It's a car battery that floats.

Linden Photonics, Inc.

Westford, MA, USA
<http://www.LindenPhotonics.com>

A versatile provider of specialty subsea cables, Linden offers patented cable designs, standing out from the larger companies offering short runs and quick turnaround. It was founded in 2002, and since its inception, Linden's design specialists have developed a range of miniature, high strength optical fiber, hybrid and specialty copper cables. Its product portfolio started with the simple, yet innovative, design of our STFOC products. Born from a naval need for a next generation Torpedo Tether, Linden pushed the boundaries of polymeric design. Linden has expanded into a worldwide cable supplier with customers in 23 countries and seven continents.

The core technology, employed in its STFOC products exploits the many novel properties of Liquid Crystal Polymers (LCPs). These unique materials are sometimes referred to as self-reinforcing polymers, and can exhibit a specific tensile strength 10 times that of steel cable. STFOC jacketing with proper alignment of polymer chains results in both high tensile strength and excellent barrier properties. Its proprietary processes yields thin, extruded strands of LCP that have a tensile modulus comparable to Kevlar.



Linden Photonics



Loggerhead Instruments

Loggerhead Instruments

Sarasota, FL, USA
<http://www.loggerhead.com/>

Loggerhead Instruments was founded in 2003 and pioneered the use of underwater acoustic recorders to extend the duration and reach of passive acoustics research. Its new line of Snap acoustic recorders are simple to use so that newcomers to underwater acoustics can easily get started. Loggerhead Instruments designs and manufactures tools for scientists to study the natural world. It pioneered underwater acoustic dataloggers, and most recently it developed high speed motion dataloggers to study animal behavior and underwater gear motion in unprecedented detail.

Multi-Electronique

Rimouski, Québec, Canada
<http://multi-electronique.com>

Founded in 1982, Multi-Electronique is serving worldwide with its oceanographic products like the AURAL M2, μ AURAL and the Instrumental Oceanographic Buoys. It is renowned for the quality of its products and the effective after-sale. The AURAL-M2 (Autono-



Multi-Electronique

mous Underwater Recorder for Acoustic Listening) is an underwater recorder used for any application that requires continuous underwater sound recording. It can record things like marine mammals, methane bubbles, underwater noise pollution.

The difference between the AURAL-M2 and the μ AURAL is the size and the autonomy. The AURAL can be sent up to a year and the μ AURAL is up to 300 hours. The Instrumental Oceanographic Buoys are conceived and developed in collaboration with Fisheries and Ocean CANADA.

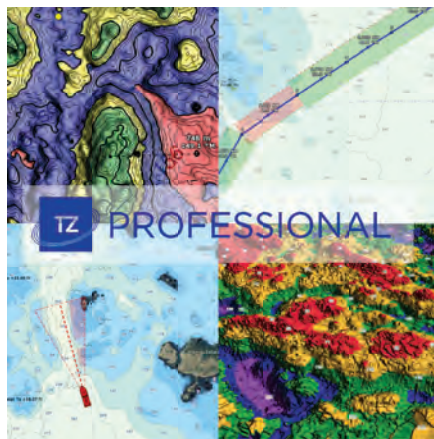
Nautilus Marine Service

Buxtehude, Lower Saxony, Germany
<http://www.nautilus-gmbh.com>

Nautilus Marine Service GmbH is a German company that was founded in 1985 and has gained international reputation by its VITROVEX deep sea glass housings along with associated services and accessories. Nautilus Marine Service provides high quality glass floatation and instrument housings in different shapes, sizes and pressure ratings up to full ocean depth. VITROVEX precision engineered glass spheres and cylinders made by Nautilus Marine Service GmbH meet the extraordinary demands of oceanographers. They are available in different diameters and pressure ratings up to full ocean depth, to match different mission requirements. A large number of accessories, including swiveling sphere attachments, self-sealing vacuum ports, pressure switches, a portable deck purge box and more, simplify the use of VITROVEX precision engineered glass housings in custom undersea vehicle development.



Nautilus Marine Service



Nobeltec Inc.

Beaverton, OR, USA

<https://mytimezero.com/>

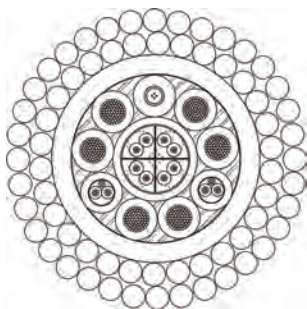
TZ Professional v3 provides a software program that has unrivalled 3D bottom mapping allowing fishermen to get insights like never before. Thanks to 30 years of working in marine navigation, TIMEZERO boasts a powerful technology that was developed with a unique vision allowing for continuous innovation. TZ Professional software has been designed to answer the navigation needs and requirements of all professional seafarers. With features that are truly cutting-edge, TIMEZERO software has two main objectives: Supreme control and performance.

TIMEZERO software caters to the user's needs no matter the activity. TZ Professional v3 software provides a powerful tool for commercial fishing that improves identifying areas with great fishing potential.

NOVACAVI

Peschiera Borromeo, Lombardia, Italy

<http://www.novacavi.it/>



www.marinetechologynews.com

Novacavi provides tailor-made cables for land, downhole, seabed, marine and multidisciplinary monitoring systems specifically engineered to perform in presence of critical depth, extreme temperatures, mechanical stress, pressure and aggressive agents. Recent leading products include P_22SSA ruggedized custom cable (pictured) to support reliable and secure monitoring activity of marine environment. This electro-optical-mechanical custom cable enriches our extremely diverse production range of subsea armoured cable for detection and instrumentation in defence and environmental monitoring applications. Key advantages of this armored halogen free low smoke cable are high working load performance, protection against electromagnetic interference, compactness and versatility. 7SSA22 custom rugged armored cable for logging downhole equipment in geothermal power plants to operate in a 4km depth geothermal well at a working temperature of more than 300°C. Its tough performance is achieved through technological and applicative expertise in choosing and working high-temperature insulations, special copper alloys and anticorrosive galvanized plow steel for armoring.

Savante Subsea

Aberdeen, Aberdeen City, UK

<http://www.savante.co.uk>

Savante Subsea, founded in 2003, is one of the longest established underwater laser and photogrammetry-based SLAM scanning companies in the world. It has developed a range of underwater laser scanners and measurement tools for use



Copenhagen Subsea A/S

Copenhagen, Denmark

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

Copenhagen Subsea A/S is trendsetting in thruster technology, developing a revolutionary series of powerful and silent subsea thrusters. It has set a new standard for testing the reliability by verifying them through an intensive 1,000 hour test. Copenhagen Subsea A/S is always attentive on new technology and endeavors to optimize the currently utilized technology. It uses the newest manufacturing technology for our innovative thruster technology, such as 3D printing for propellers.



with ROVs, divers and seabed landers. Savante has pioneered the development of 5D laser measurement solutions in the underwater environment. Its equipment is widely operated aboard remotely operated vehicles, divers (from SCUBA to saturation gas), a range of seabed landers and towed benthic sledges.

TechWorks Marine

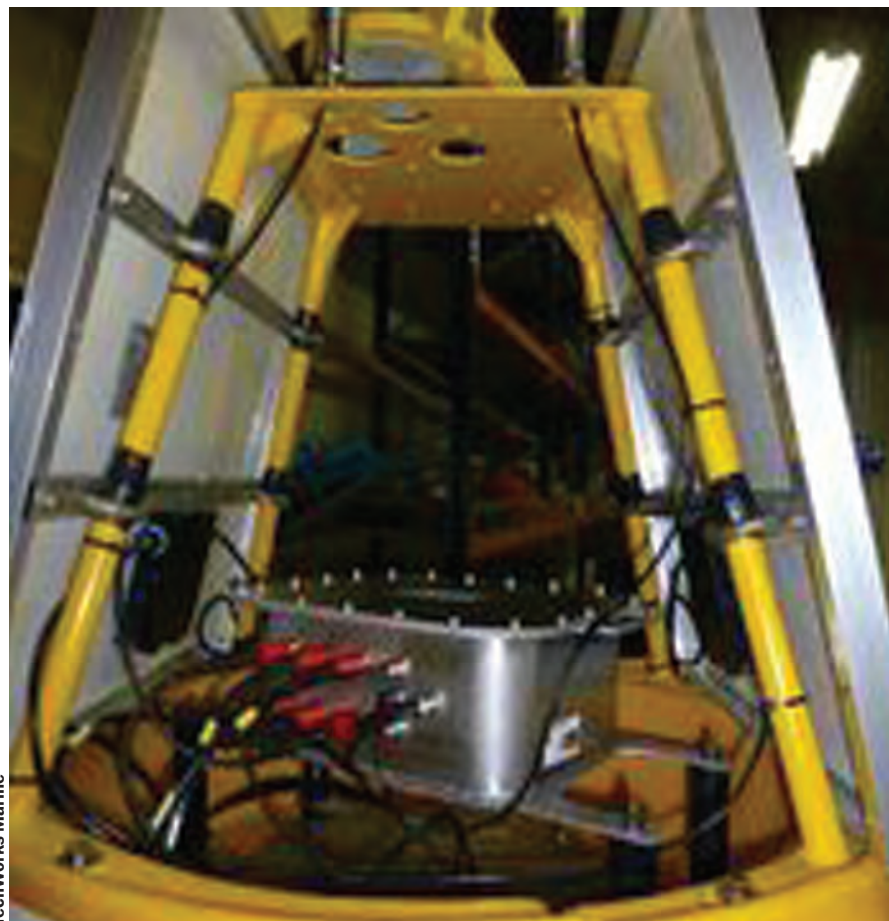
Dublin, Ireland

<http://www.techworks.ie>

TechWorks Marine are leaders in marine data, offering marine data solutions to a broad range of clients, providing systems on a sale or lease option depending on their specific requirements. Core to its marine data systems are the TMBB command and control system and CoastEye, the web-based data portal. These allow management of marine assets remotely. Many different data streams can be integrated to CoastEye, including Earth Observation and model data.

TechWorks Marine represents a number of leading international oceanographic sensor suppliers, including Nortek, Seabird Scientific, Pro-Oceanus, McLane, VideoRay and Xeos. TechWorks Marine offer full metocean services including:

- Real-time integrated marine data buoy networks
 - Tidal and wave resource assessment
 - Wave measurement surveys for model validation
 - Current profile measurement for model validation
 - Tidal surveys
 - Water quality monitoring
 - Real-time dredge monitoring buoy networks.
 - Water and sediment sampling and analysis
 - Meteorological measurements
 - Hydrographic surveys
- Our consultancy services include project management, site supervision, risk assessment and independent evaluation in support of field campaigns.



TechWorks Marine



Sidus Solutions

Sidus Solutions

San Diego, CA, United States

<http://www.sidus-solutions.com/>

Sidus Solutions, LLC is an integrated systems provider of security and video surveillance systems for worldwide businesses in the research, heavy industry, commercial, military, oil and gas markets. It is a full service provider, offering complete end-to-end solutions from concept design, product selection, engineering, manufacturing, technical and customer support. Specializing in subsea cameras, robotic-positioning, and lighting systems, Sidus services and manufactures complete, integrated security and surveillance solutions for any subsea application. Sidus equipment, operational to 6,500m depths, is available alone or to integrate with existing systems. From concept design to technical support, Sidus has solutions for every need.

SIDUS is a global leader in the design and manufacturing of subsea positioners, cameras, lighting, lasers, & inspection systems. SIDUS products improve safety, efficiency and ease of operation in challenging environments.

Riptide Autonomous Solutions

Pembroke, MA, USA • <https://riptideas.com> • Annual Sales: \$5 million

Riptide has pioneered a new class of UUV: a low-cost open source micro vehicle. In addition to the technical achievement, use of modern manufacturing techniques has allowed the price of the vehicle to be roughly \$15,000. This has been accomplished in less than two years. In 2015, several veterans of the conventional UUV sector set out to change the dynamics of the industry, founding Riptide Autonomous Solutions. Riptide is led by **Jeff Smith (pictured below)**, the former COO of Bluefin Robotics. The team also includes Dr. Dani Goldberg, another Bluefin veteran, as principal software engineer. Senior advisors to the company include Michael Kutzleb founder of Phoenix International; David Kelly, CEO of Innovasea; and VADM (ret) Michael Connor. Riptide is a young entrant in the mature marine robotics community in Massachusetts. Founded by veterans of the maritime industry, the team is supported by relationships with academics such as Dr. Stefano Brizzolara of MIT and various consultants. The company's core expertise is rapid design and development of compact and affordable marine robotics. To date the company has developed and delivered a novel micro-UUV that provides significant capability at a low price point, under \$15,000.

Riptide's first product is the micro-UUV, a highly flexible, open source vehicle that pro-

vides a state-of-the-art, low cost solution for UUV users. The micro-UUV features open hardware and software interfaces giving users a reliable platform to advance technology development. The vehicle design is optimized for high efficiency with the best hydrodynamic signature in its class. The base micro-UUV is 4 7/8 inches in diameter, 40 inches in length and weighs 22 lbs. The standard system is rated to a depth of 300 meters. Riptide's micro-UUV features three individually actuated control fins providing active roll stabilization. An active GPS antenna, WiFi communications, and vehicle recovery strobe LEDs are integrated into the vertical control fin, for maximum efficiency. Open system design provides for easy user modification and customization, making this an ideal platform for a wide variety of development needs. Multiple energy source options allow maximum flexibility for endurance, safety, shipping, and mission optimization.

The micro-UUV architecture maximizes the use of existing open source software, both to provide a mature platform and to tap into existing energetic user communities. In the initial release of micro-UUV software, Riptide provided code for the Arduino and Beaglebone Black development platforms, as well as support for the MOOS-IvP robot control engine. Future releases will support for ROS (the Robot Operating System).



Riptide



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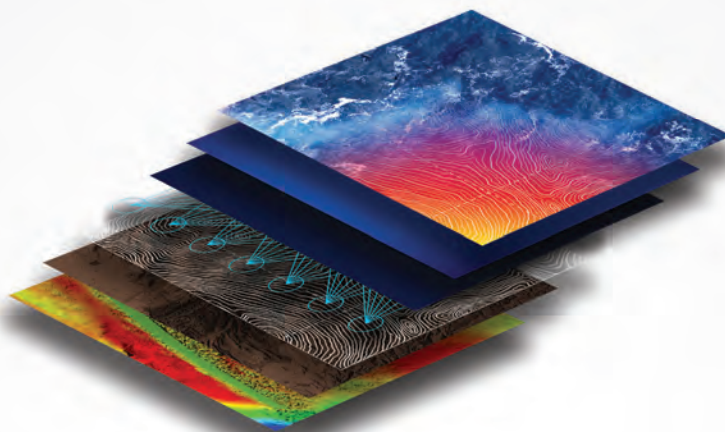


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AQUACULTURE



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MONITORING STRUCTURAL INTEGRITY



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Tim French

+ 44 (0)20 8910 7108

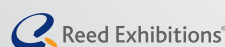
tim.french@reedexpo.co.uk

Dominic Cole

+ 44 (0)20 8910 7773

dominic.cole@reedexpo.co.uk

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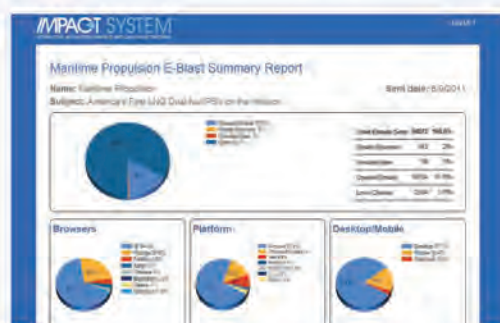
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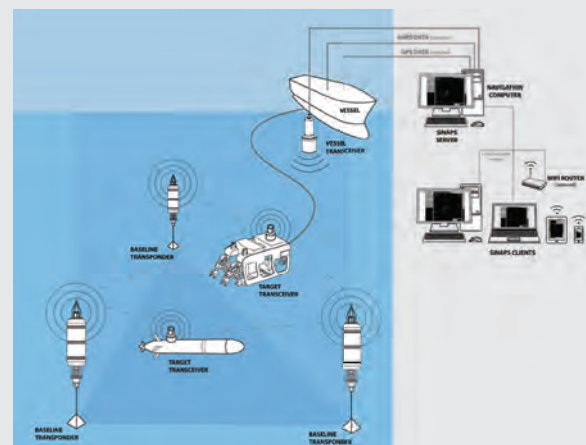
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