MARINE TECHNOLOGY REPORTER

March 2017

www.marinetechnologynews.com

Cluster Focus
Southern California

Greensea redefines the connection between Man & Machine

Oceanographic Instrumentation
SuBastian Explores the Marianas

Product
Sonar & Seafloor Mapping

Fiber Optics
Connector Tech for Oil & Gas Ops

Volume 60 Number 2

VideoRay

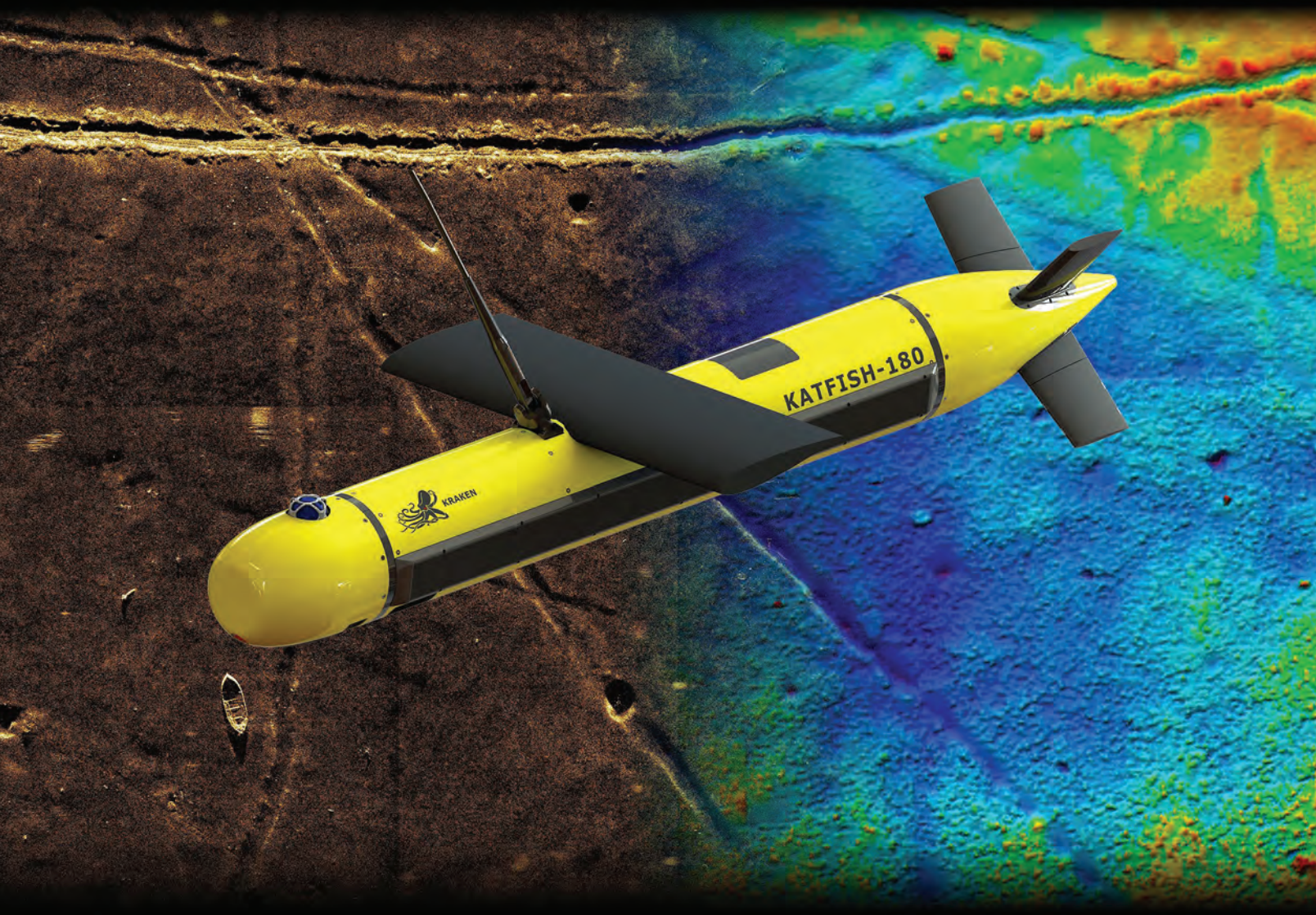
Your success drives everything we do. That's why we've engineered every aspect of our ROV systems with you in mind. VideoRay offers affordable, reliable, and robust ROV systems that get the job done right the first time. There's a reason why more customers have chosen VideoRay inspection class ROVs than any other ROV solution on the market. From our unparalleled customer service to our innovative training programs, VideoRay gives you confidence underwater.

www.videoray.com

Photo Credit: Matt Majors

Uncover the Details.

KATFISH - Actively Controlled Towed SAS System



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

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

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

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

For more information, email info@krakensonar.com.

KRAKEN

www.krakensonar.com

March 2017
Volume 60 • Number 2

Contents

Greensea Systems

Riptide

Schmidt Ocean Institue

On the Cover

Command & Control

34 Man & Machine
Ben Kinnaman and his Greensea Systems team are determined to deliver the standard operating platform for the marine industry.
By Greg Trauthwein

Fiber Optics

22 Connect the Dots
Fiber optic connector technology for oil and gas operations.
By Jeremy Calac & Michael Mulcahy

Innovator

28 Beware the Riptide
Riptide Autonomous Solutions was created to deliver an innovative, low-cost UUV to fuel a growing market.
By Justin Manley & Jeff Smith

Oceanographic Instrumentation

44 Uncharted Depths
Exploring the Marianas with SOI's SuBastian.
By Kira Coley

Sonar & Seafloor Mapping

52 Better Measurements, Fast
Verification of subsea metrology.
By Gordon Beattie

Voices

66 Margaret Leinen
The Director of Scripps Institution of Oceanography leads off the Southern California Subsea Cluster Focus.
By Greg Trauthwein

I FIND WRECKS. I SOLVE MYSTERIES.

I AM REMUS

HYDROID
A KONGSBERG COMPANY

Intelligent Marine Robots You Can Rely On

OUR REMUS VEHICLES
work for you to complete your mission –autonomously– whether solving underwater mysteries, performing site investigations or studying the ocean floor.

To learn more, visit **HYDROID.COM/IAMREMUS**

Photo: Greensea Systems

www.marinetechnologynews.com

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

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

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

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

Managing Editor
Eric Haun
haun@marinelink.com

Contributing Writers
Kira Coley, United Kingdom
Capt. Edward Lundquist, USN (Ret.)
Tom Mulligan, Ireland
Claudio Paschoa, Brazil
William Stoichevski, Norway

Production Manager
Irina Vasilets
vasilets@marinelink.com

Production & Graphic Design
Nicole Ventimiglia
nicole@marinelink.com

Corporate Staff
Manager, Marketing
Mark O'Malley
momalley@marinelink.com

Accounting
Esther Rothenberger
rothenberger@marinelink.com

Manager, Information Technology Services
Vladimir Bibik
bibik@marinelink.com

Circulation
Kathleen Hickey
mtrcirc@marinelink.com

Advertising

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

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

Editorial

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

This year's busy travel season started with a new twist, the inaugural Oceanology International North America held in San Diego mid-February. The event featured a literal 'who's who' of industry executives and leaders, in town for three days for the typical mix of conference, exhibition and networking. This month we focus on the Southern California Subsea Cluster, and this was an ideal opportunity to reconnect with a number of companies in the region. The strength and influence of the Blue Economy in this region has grown appreciably in recent years, with Scripps Institution of Oceanography and the U.S. Navy serving as the bedrock; a strong and growing cast of support companies and technologies; and the 24/7/365 support of The Maritime Alliance and a strong and growing political backing.

The event in San Diego also served as the unofficial launch point for "Marine Technology TV," the latest addition to our MTR media brand that today includes more than a dozen topical interviews with industry leaders. We thank all of our first interviews, particularly **Margaret Leinen**, Director, Scripps Institution of Oceanography. http://www.marinetechnologynews.com/videos/video/interview-margaret-leinen-director-scripps-institution-of-100004. Leinen also is the feature subject of our lead-in feature for the Southern California Subsea Cluster section starting on page 65.

Our cover story this month comes from the east coast, my side of the country, as I recently had the opportunity to travel to Richmond, Vermount, to meet with **Ben Kinnaman**, CEO and President of Greensea Systems. Kinnaman's company is small and young but growing by leaps and bounds, as its OPENSEA software backbone increasingly spreads its influence through maritime and subsea circles. Greensea is diverse in capability and certainly a company to watch in the coming years as Kinnaman and his crew seek to redefine the connection between man and machine. The cover story starts on page 34.

MARINE TECHNOLOGY REPORTER
www.marinetechnologynews.com
Vol. 60 *No. 2*
ISSN 1559-7415
USPS# 023-276
118 East 25th Street,
New York, NY 10010
tel: (212) 477-6700
fax: (212) 254-6271

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

POSTMASTER: Send all UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Marine Technology Reporter, 850 Montauk Hwy., #867, Bayport, NY 11705.

Subscription:
To subscribe please visit
www.marinetechnologynews.com

DEEP OCEAN ENGINEERING

RUGGED

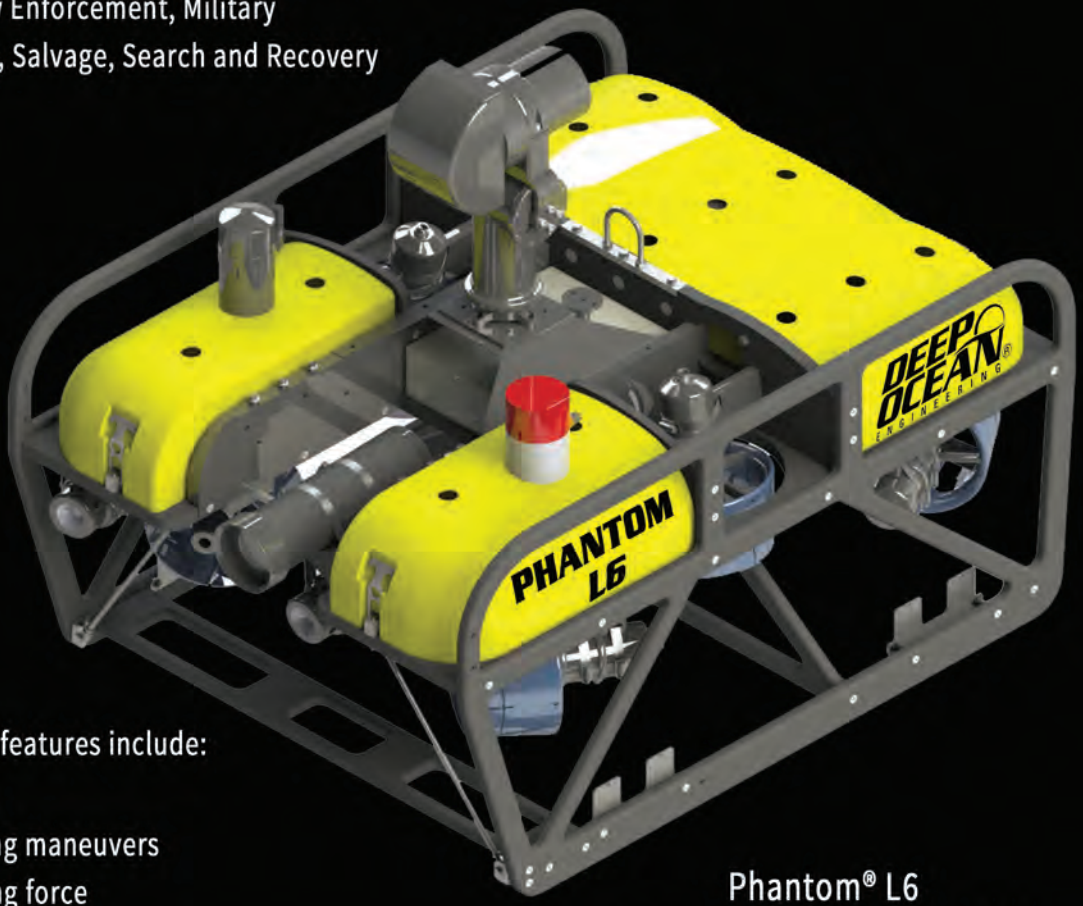
EXPANDABLE

POWERFUL

Deep Ocean Engineering Introduces Phantom® L6

The Phantom® L6 applications include:

- Infrastructure Inspections - Bridges, Tunnels, Pipelines, Ships
- Hydroelectric System Monitoring - Power Plants, Dams, Reservoirs
- Homeland Security – Law Enforcement, Military
- Exploration - Oil and Gas, Salvage, Search and Recovery



Phantom® L6
optional USBL and sonars available

The Phantom® L6 platform features include:

- Active roll stabilization
- Advanced dynamic rolling maneuvers
- 110 pounds vertical lifting force
- Easily reconfigurable and customizable
- 18,000 lumens high output illumination

www.deepocean.com

408-436-1102

BUILT TO YOUR REQUIREMENTS IN SILICON VALLEY, USA

Calac

Coley

Mulcahy

Calac

Jeremy Calac is Product Manager – Optic and HPHT Systems, TE Connectivity – Marine Oil and Gas With a Master of Science degree with optical techniques specialties and experience as an École Nationale Supérieur d'Ingénieurs du Mans (ENSIM) Graduate Engineer at the Université du Maine in France, Calac has more than eight years of experience in providing connectivity solutions for the offshore oil and gas market. He currently supports projects for topside, subsea and downhole applications as a Product Manager for Optic & HPHT Systems for TE's Marine, Oil and Gas business. His areas of expertise include electrical and optical dry/wet mateable connectivity solutions for subsea distribution, HPHT (High-Pressure, High Temperature) applications, reservoir surveillance and oil recovery improvement.

Coley

Kira Coley is a freelance science writer and regular contributor to *Marine Technology Reporter*. She is a lecturer in science communication and a PhD researcher.

Mulcahy

Michael Mulcahy is a former U.S. Navy officer. He has written more than 100 articles for ocean engineering publications. His interests include undersea connectors and cables; marine engineering, naval architecture, commercial diving, remotely operated vehicle operations and ship salvage engineering. He is a graduate of the University of North Carolina at Chapel Hill.

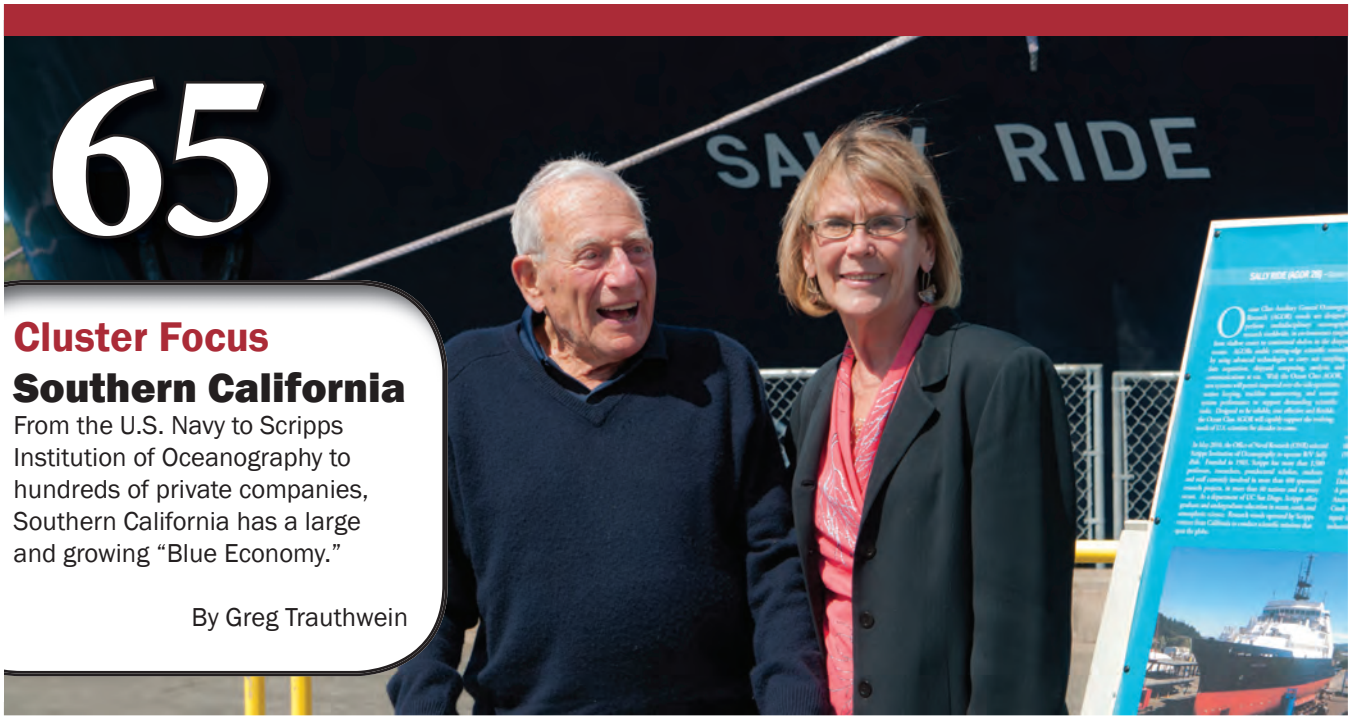


Photo: Scripps Institution of Oceanography

Cluster Focus
Southern California

From the U.S. Navy to Scripps Institution of Oceanography to hundreds of private companies, Southern California has a large and growing "Blue Economy."

By Greg Trauthwein

Best choice ever

for underwater tasks everywhere
the future is electric

WORLD LEADER IN UNDERWATER e-ROBOTIC SYSTEMS

SAAB

SAAB SEAEYE

THE FUTURE IS ELECTRIC

... In case you missed it, highlights from marinetechnologynews.com and the Marine Technology Reporter ENews ...

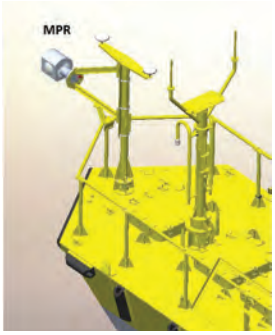
Photo: Matrix New World Engineering

New Artificial Reef

Kraken, a 6,000-ton, 371-foot retired cargo vessel, was scuttled 67 miles off Galveston to help create an artificial reef to support coral, fish, sea turtles and other aquatic life in the Gulf of Mexico. The ship's new resting place is in close proximity to the Flower Garden Banks National Marine Sanctuary, a triad of coral reef systems popular with divers and fishermen.
http://www.marinetechnologynews.com/news/video-retired-artificial-544771

World's First Floating Microwave Radiometer

AXYS Technologies Inc. is conducting design work with Boulder Environmental Sciences & Technology (BEST) to deploy the world's first buoy based microwave profiling radiometer on a floating platform, the FLiDAR WindSentinel. Funded by the U.S. Department of Energy, the BEST Marine Profiling Radiometer (MPR) is the world's first microwave profiling radiometer specifically designed for deployment on a buoy.
http://www.marinetechnologynews.com/news/world-first-floating-microwave-544561



AXYS Technologies

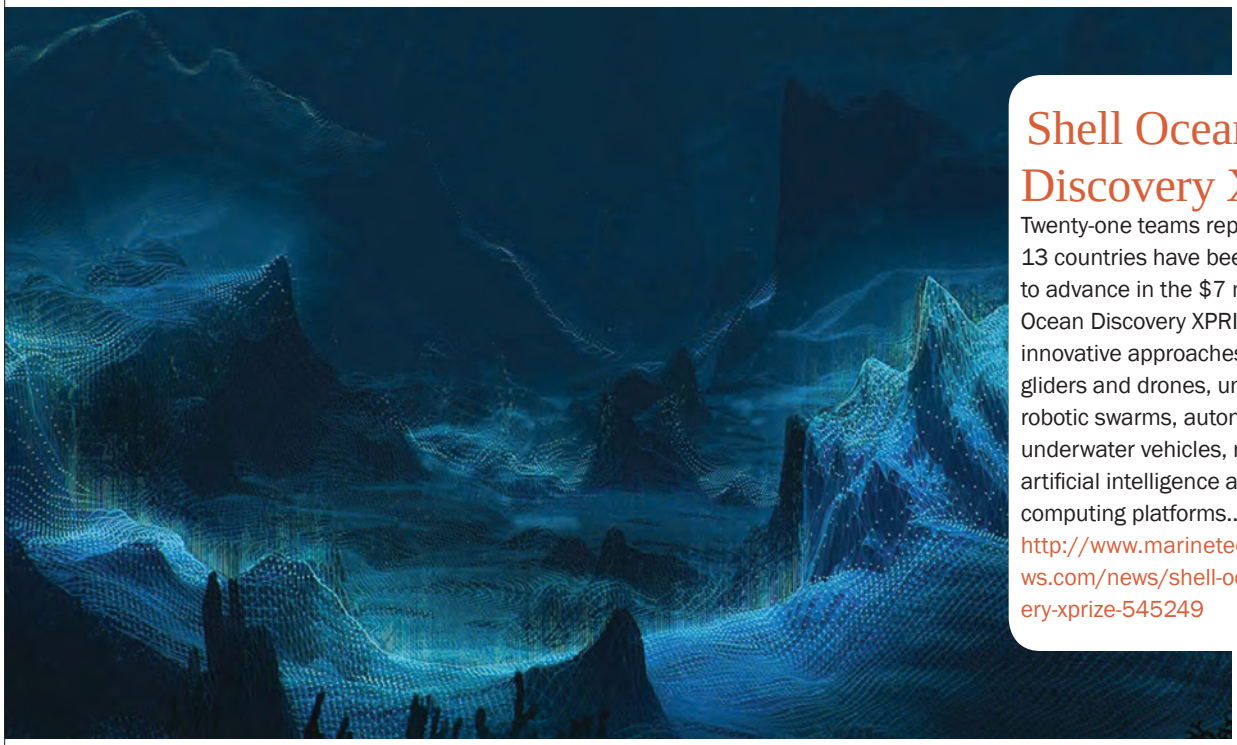
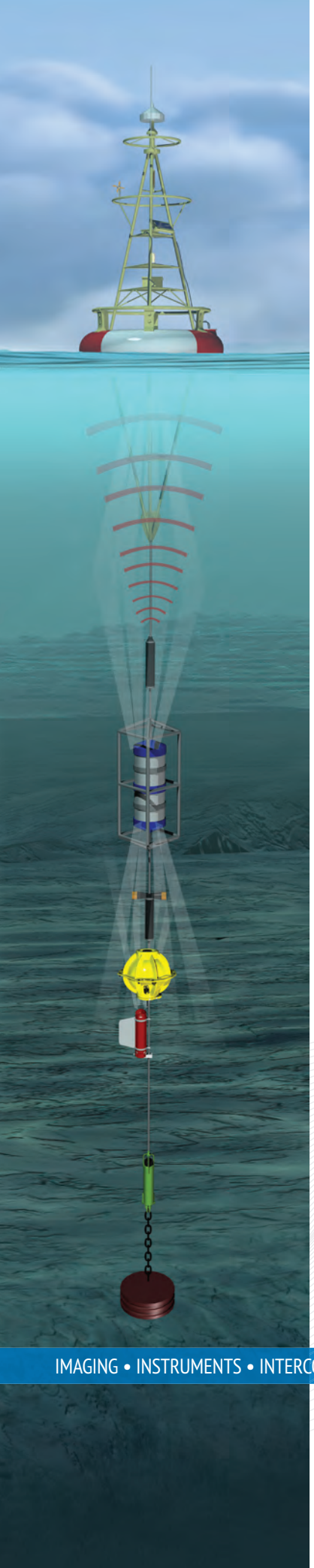


Image: XPrize

Shell Ocean Discovery XPrize

Twenty-one teams representing 13 countries have been chosen to advance in the $7 million Shell Ocean Discovery XPRIZE. Their innovative approaches run from gliders and drones, underwater robotic swarms, autonomous underwater vehicles, robotics, artificial intelligence and massive computing platforms..
http://www.marinetechnologynews.com/news/shell-ocean-discovery-xprize-545249



Instrumenting a Mooring?

Teledyne Marine has you covered!

Only Teledyne Marine has the proven, industry-leading instruments you need ***– all from a single supplier***.

With Teledyne Marine's new One Team sales structure, customers can now enjoy single point access for all of their mooring instrumentation needs, saving you time and money during your sourcing and procurement process, while providing you with the peace of mind that comes from working with the industry's leading experts in their fields.

Teledyne Benthos **Acoustic Modems** allow for real-time, wireless communications in shallow or deep water environments

Teledyne RDI's **Acoustic Doppler Current Profilers (ADCPs)** deliver highly accurate current data in up to 6000M of water.

Teledyne RDI's **Citadel CTDs** provide accurate Conductivity, Temperature and Depth measurements

Teledyne Benthos **Glass Housings** can house other instrumentation and/or relieve dangerous mooring strain.

Teledyne **Benthos Acoustic Releases** ensure that you get your mooring and critical data back.

IMAGING • INSTRUMENTS • INTERCONNECT • SEISMIC • VEHICLES

TELEDYNE MARINE

Everywhereyoulook™

www.teledynemarine.com

MarineTechnology TV Debuts in San Diego

At the Oceanology International North America exhibition in San Diego *Marine Technology Reporter* rolled out its new "Marine Technology TV" brand, welcoming more than a dozen industry leaders and executives to its 'booth/studio' for short interviews on a topic or technology. Interviewees were gracious with their time and insight, and included **Margaret Leinen**, Director, Scripps Institution of Oceanography (below + see our print interview with Leinen starting on page 66) and **Jeffrey M. Smith**, President and CEO, Riptide Autonomous Systems (right + see an article by Smith and Justin Manley starting on page 28).

http://www.marinetechnologynews.com/videos

NAVIGATOR

A one man navigation and sonar reconnaissance unit

SHARK MARINE TECHNOLOGIES INC.

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

Proven

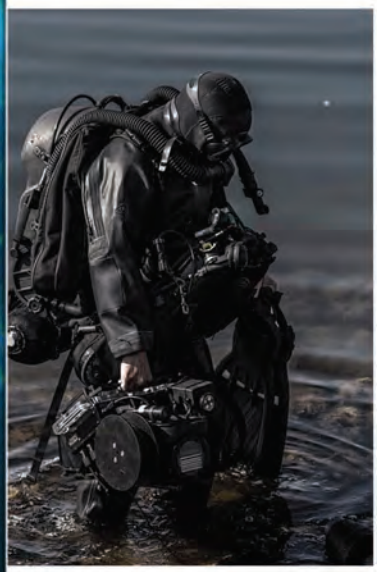
Tested and proven, the Navigator is the trusted choice of 17 Navies, as well as Law Enforcement, Search and Rescue Teams and Scientific Researchers spanning the globe. The Navigator has become a critical part of the Standard Kit and has reshaped SOPs. The modularity of the system and numerous advanced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

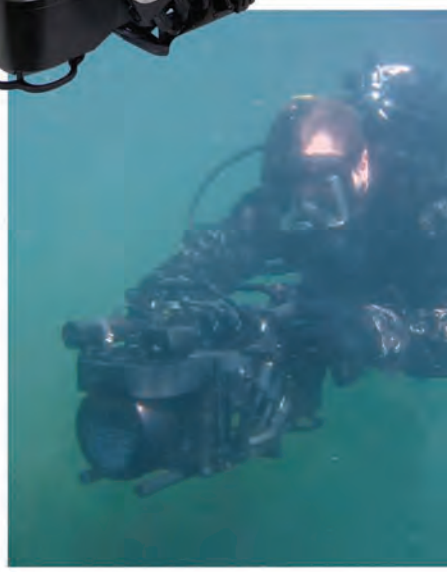
Mission Ready

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

Intuitive

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





www.sharkmarine.com sales@sharkmarine.com Ph: (905) 687 6672

People & Companies

Photo: AUS

Eakin

Photo: STR

Elliott

Photo: Ecosse

Middleton

AUS Hires Eakin

Michael J. Eakin has joined the Associated Underwater Service's (AUS) management team as a Senior Estimator and Director of Business Development. Working out of the Seattle office, Eakin will oversee customer relations, product line development, sales and marketing nationwide. He will also provide estimating services for Western Washington as well as the West Coast.

STR Names Elliott Asia Pacific GM

Subsea Technology & Rentals Ltd (STR) global specialists in the design, production and rental of advanced subsea technology for the offshore industry, has appointed Paul Elliott as General Manager for the Asia Pacific Region. Elliot will be responsible for working with STR's existing customers and agents within the Asia Pacific region to support business and develop new opportunities and relationships.

Middleton Joins Ecosse Subsea

Ecosse Subsea Systems (ESS) appointed Iain Middleton to the newly created role of commercial manager, allowing commercial director Keith McDermott to continue to pursue new business opportunities for Ecosse in the Asian and U.S. renewables and oil and gas sectors, and to focus on strategic developments.

Grady Joins Aqueos

Marine construction and subsea services provider Aqueos Corporation has appointed David Grady to the position of Project Manager-Special Projects.

MacIntosh Joins OceanWorks

OceanWorks International has appointed Andrea MacIntosh to the position of Operations Manager. MacIntosh will take the reins of the OceanWorks' Vancouver facility in anticipation of an expected increase in the number of projects to be completed in 2017. Among her many tasks, she will be responsible for the on-time delivery of products and program deliverables.

Fugro's Heine Joins IMCA Board

The International Marine Contractors Association (IMCA) has confirmed the appointment of Mark Heine to its governing board. Heine is a senior executive with Fugro.

Gougeon Named CEO at OpenHydro

OpenHydro, the Irish based tidal energy company and part of DCNS Energies, has appointed Patrick Gougeon as its new Chief Executive Officer. The appointment signals the company's ongoing drive toward commercialization of its tidal technology and follows the launch of DCNS Energies, a subsidiary of the DCNS Group. Gougeon joined OpenHydro at the start of January 2017, having previously held the position of CEO of Colibrys, a high-technology industrial company based in Switzerland.

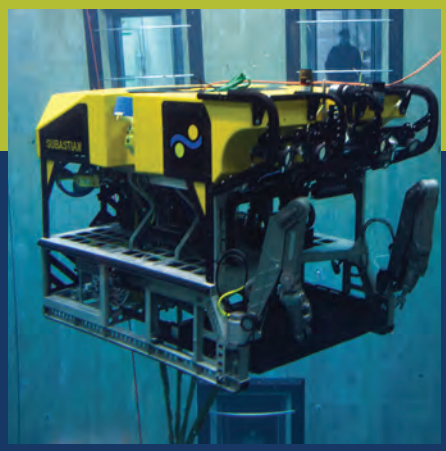
AMIRIX's Acquisition of HTI Finalized

An agreement has been reached for AMIRIX Systems, Inc of Halifax, Nova Scotia, Canada to acquire Hydroacoustic Technology, Inc (HTI) of Seattle. The acquisition became official on February 1, 2017. HTI will operate as a new business unit under the name HTI-Vemco USA, Inc. alongside the VEMCO business unit of AMIRIX to create a comprehensive provider of acoustic products, tools and services for aquatic animal monitoring. HTI and Vemco will continue to operate as separate business units under AMIRIX. HTI and Vemco will collaborate to develop the next generation of products and services for fish research.

Saab Seaeye Invests in Engineers

Saab Seaeye has launched a recruitment drive to find software and electrical engineers at all levels, including senior engineering management, for its Fareham, Portsmouth, Head Office and manufacturing base. According to the company, the increased investment comes as rapid advances in miniaturization and control architecture

These vehicles have two things in common:



Water and us.

Greensea's universal operating platform is a proven technology, already in use in more than 600 manned, unmanned, surface, and subsea marine vehicles. Our platform integrates navigation and vehicle control and allows for critical data to be shared throughout the system. Station keeping, dynamic positioning, target tracking and target re-acquisition are at your fingertips. All our systems are supported by Workspace, our intuitive, one-screen interface. With Greensea on board, you can stay squarely in control of your vehicle and your mission.

For more information, download our brochure at Greenseainc.com/brochure or call 802.434.6080.

GREENSEA


Photo: Aqueos

Grady


Photo: OceanWorks

MacIntosh


Photo: Saab Seaeye

Saab Seaeye

are creating smaller, smarter robotic systems that are more agile, more powerful and are bringing advanced technology and efficiencies to an ever widening range of complex tasks across many different market sectors.

M² Subsea Opens New HQ

M² Subsea, which secured private equity investment toward the end of 2016, has moved people and equipment into new headquarter premises in Aberdeenshire. The company has recruited onshore commercial and operational personnel, taking possession of 27 remotely operated vehicles (ROVs) and mobilizing 10 of them onto a diverse fleet of subsea vessels. The company, which is also based in Houston, expects to create 50 onshore and 100 offshore jobs by the end of the year. Around 30 people have joined the management team in the U.K. and the U.S. with more expected to be recruited as imminent contracts are signed.

Rovco Dives In

Rovco, a U.K.-based startup launched in September, has stepped into international waters with the completion of two subsea survey contracts in Southeast Asia and the Middle East. The contract awards saw Rovco perform advanced subsea survey work in Fiji and Oman, utilizing its SubAtlantic Mojave, Seaeye Falcon and VideoRay Pro 4 ROVs. The company has also been awarded its first ROV consultancy project with one of a U.K. engineering solutions provider and recently employed two new ROV pilots.


Photo: LloydRegister

Inglis

New Training Courses from Teledyne

Teledyne RESON A/S announced a new series of SeaBat and Teledyne PDS training courses set at different locations on the latest hardware and software technology. Teledyne PDS and Teledyne SeaBat Multibeam Sonars are used for many seabed mapping and dredging operations. The open courses cover Teledyne PDS for Dredge or Multibeam operations and SeaBat training. Teledyne also offers a combined training session covering everything from SeaBat installation to producing a deliverable in Teledyne PDS.

LR Sets Its Sights Subsea

Lloyd's Register (LR) aims to bring its expertise to underwater operations in offshore oil and gas as well as wind farm power generation and submarine cable markets, having launched Subsea Inspection Services It will be headed by LR's Subsea Inspection Manager Andrew Inglis.

The Cluster of Clusters

Marine technology clusters from seven countries have come together to launch a global BlueTech Cluster Alliance (BTCA) to foster innovation and economic development in the maritime domain.

Together the clusters will promote sustainable, science-based ocean and water industries and advance cluster-to-cluster and B2B collaboration "through events and initiatives that promote the blue economy and share common goals of fostering economic development, innovation and scientific discovery in the maritime domain." Charter Members are Forum Oceano (Portugal), Marine Institute (Ireland), Oceans Advance (Canada), PLOCAN (Spain), Pole Mer Mediterranee (France), The Maritime Alliance (U.S.), UK Blue Growth Network (UK), and Pôle Mer Bretagne Atlantique is the first Regular Member. BTCA will expand membership to other BlueTech clusters.

Centre for Marine Simulation
Fisheries and Marine Institute

Canada's Centre for

Ocean Technology

Newfoundland and Labrador is a place where companies and researchers use innovative technologies to overcome the challenges of operating in a cold-ocean environment.

Our technology innovators are engaged in providing solutions for offshore energy development, fisheries and aquaculture, ocean observation and monitoring, transportation, climate change adaptation, marine recreation and tourism, and defence and security.

Offering the most accessible and southerly location with Arctic-like marine conditions, Newfoundland and Labrador is strategically positioned for success on the *Path to the Arctic™*.

Newfoundland Labrador
CANADA

btcrd@gov.nl.ca
gov.nl.ca/BTCRD

Ocean Business 2017

Photo: Ocean Business

Ocean Business 2017 – the global ocean technology show combining an exhibition and program of hands-on training and demonstration sessions.

Ocean Business 2017 is scheduled to take place at the National Oceanography Center in Southampton, U.K. from April 4 to 6, 2017. Firmly established as one of the most important international events in the ocean technology calendar, Ocean Business is free to attend and is expected to attract more than 5,000 visitors from more than 60 countries.

At the heart of Ocean Business is a three-day exhibition of more than 340 companies, bringing together manufacturers and service providers in the industry. The exhibition center is located directly on the waterfront at the National Oceanography Centre. The exhibition provides visitors with the opportunity to see companies displaying the very latest in the industry all under one roof.

More than a static exhibition, Ocean Business provides visitors with an opportunity to test-drive equipment and systems with more than 180 hours of live training and demonstration sessions. Products and services are demonstrated in their real environment with sessions held on board vessels, in dockside waters, in a test tank and in classrooms.

The Conference

Running alongside the exhibition and workshops is a conference designed to keep visitors at the forefront of the industry. This conference will target maritime dual-use opportunities in autonomous systems and satellite applications, both of which are on a growth curve for investment, and are attracting widespread interest across public and private sectors. Many organizations within the industry choose Ocean Business as the place to hold associated meetings. Attend a variety of seminars held by leading organizations in the industry from around the world and keep abreast of the latest developments in ocean technology.

Networking

The 2017 Ocean Business social program offers plenty of enjoyable events for informal and formal networking. On the night before the show opens, all exhibitors and visitors are invited for complimentary welcome drinks. On the first day of the show, the popular wine trail will be held in the exhibit halls and on the second day the highly anticipated gala dinner will be held at The Grand Cafe, one of Southampton's most prestigious venues.

Running alongside Ocean Business is Ocean Careers, offering advice and career opportunities within the ocean technology, marine science and offshore industries. Incorporating a mix of one-to-one meetings and presentations from industry leaders, Ocean Careers is an interactive event designed for all those looking to move into the industry. It is clearly becoming harder for many graduates, newly qualified engineers and the unemployed to find work. Whether your skills are in engineering, science or mathematics, Ocean Careers can help you realize how these skills can be utilized in this vast, exciting, forward thinking and diverse industry.

Register online at:
www.oceanbusiness.com/register

BLUEFIN ROBOTICS

BLUEFIN SANDSHARK™

BLUEFIN-9

BLUEFIN-12

BLUEFIN-21

GENERAL DYNAMICS MISSION SYSTEMS

offers a family of **Bluefin Robotics Autonomous Underwater Vehicles (AUVs)** and related technologies for defense, commercial, and scientific customers worldwide. We offer a full range of modular, free-flooded AUV platforms. Bluefin-21 is capable of launching payloads such as the Bluefin SandShark™ and unmanned aerial vehicles.

www.**bluefinrobotics**.com

ORDER NOW!
BLUEFIN SANDSHARK™ MICRO AUV

GENERAL DYNAMICS
Mission Systems

Ocean Mapping: Fugro Partner with Shell on X-Prize

Fugro will use its deepwater survey expertise to support the Shell Ocean Discovery XPRIZE with high resolution bathymetry data of the competition area.

Fugro will partner with the Shell Ocean Discovery XPRIZE to support first round testing of the global, three-year competition, which incentivizes development of rapid, unmanned and high resolution ocean mapping technologies.

Fugro's role is to provide high resolution deepwater baseline bathymetry data over a 500 sq. km competition area. The company has recently collected more than 1 million sq. km of high resolution bathymetry data per year globally, predominantly in water depths greater than 750 meters.

Fugro will acquire the seafloor data using a deepwater autonomous underwater vehicle (AUV) equipped with sonar-based survey systems. This information will be used to ground-truth the work of 21 semifinalist teams advancing to Round 1 of the competition. The challenge for the competing teams is to deploy their inventions to operate at 2,000 meters ocean depth, mapping 20% of the project site at 5 meters resolution, and identifying at least five archaeological, biological or geological features, all within a 16-hour timeframe.

"The semifinalist teams in the Shell Ocean Discovery XPRIZE are pushing the envelope of deep sea mapping capabilities, and we are delighted to partner with Fugro on this common goal of mapping the world's oceans," said Jyotika Virmani, Ph.D., prize lead and senior director of XPRIZE's Energy and Environment Group. "Fugro's global subsea experience ensures that we will have baseline maps of the highest standards, against which the judging panel can compare the data collected by competing teams."

Given that 85% of the world's oceans is yet to be mapped using modern survey techniques, there is a lot of seabed yet to cover. "Fugro is working on a number of fronts to help close this data gap," said David Millar, Fugro's director of hydrographic services for the Americas. "Our partnership with the Shell Ocean Discovery XPRIZE is especially exciting, as the competition could result in game-changing technology that will be for the benefit of industry and our understanding of the world's oceans."

In addition to increasing the speeds and methods by which baseline bathymetry could be acquired, the competition offers a special $1million incentive sponsored by the U.S. National Oceanic and Atmospheric Administration (NOAA) for systems that can also detect and track biological and chemical signals. Such advancements would improve emergency response and foster the discovery and monitoring of new marine life and underwater communities.

First round testing for semifinalist teams is scheduled to commence in September 2017. Fugro will acquire, process and deliver the high resolution baseline datasets in advance.

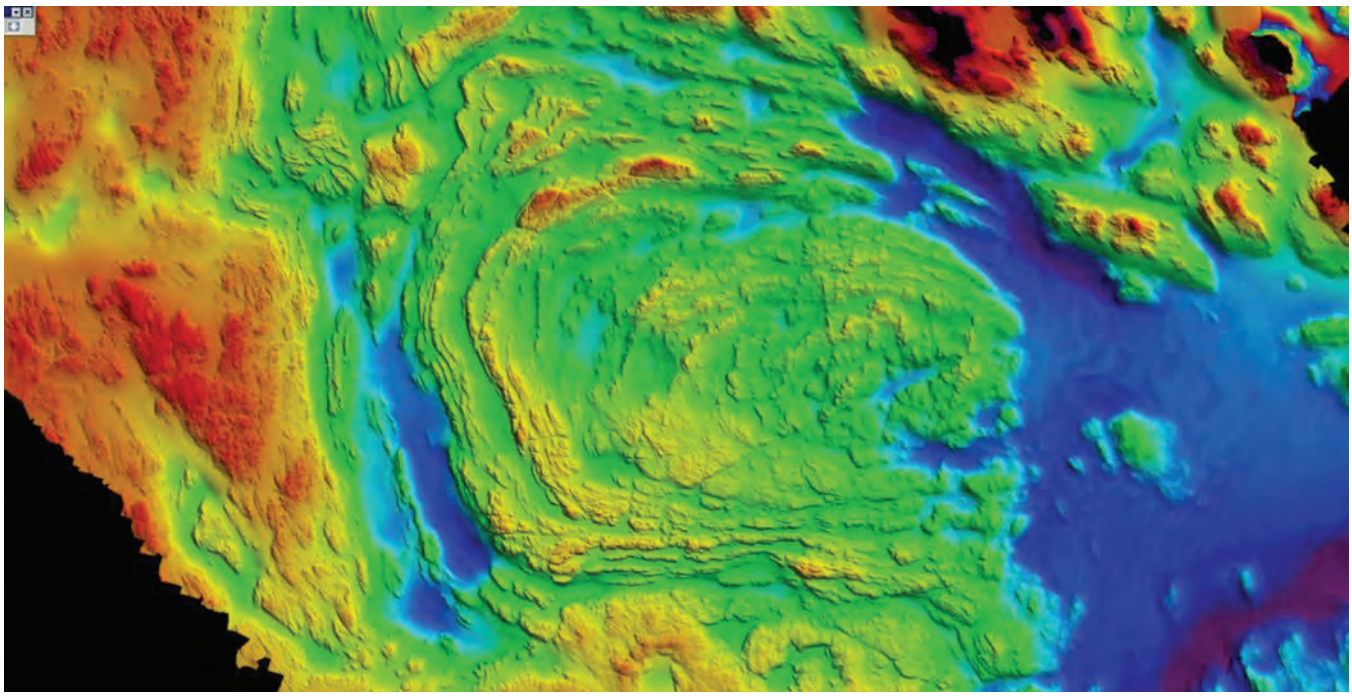


Photo: Fugro

Leading Hi-Tech Global Supplier of Piezoelectric Ceramics and Components!

APC International, Ltd.

In-House Facilities - Provide Custom Development & Assemblies

Ensuring Realibility - Of Every Day Medical Devices

Focused on Customer Needs - Supporting Successful Piezo Projects

Providing Precision Components -That Ensure Our Security

www.americanpiezo.com
213 Duck Run Road, PO Box 180, Mackeyville, PA 17750 USA
Telephone: +1-570-726-6961 Fax: +1-570-726-7466

Case Study

Mapping a Glacial Landslide

In October of 2015, a massive landslide was detected at Tyndall glacier in southeast Alaska, sending an estimated 145 million tons of valley wall into Taan Fiord. The landslide's significant mass created a seismic signature that was detected by seismologists thousands of miles away at Columbia University in New York. Taan Fiord is an arm of Icy Bay in southeast Alaska. Over thousands of years, Tyndall Glacier eroded the valley walls creating very steep sidewalls. Over the past several decades, Tyndall Glacier has retreated, no longer supporting those sidewalls. The steepening and then debuttressing of the walls caused the sidewalls to collapse catastrophically in the form of a massive landslide.

Remote Area Survey with Z-Boat 1800RP

Products: Z-Boat 1800RP
Application: Remote Area Survey
Project: Taan Fiord Landslide Assessment
Customer: University of Washington Tacoma, Dr. Dan Shugar

Photo: Dan Shugar

With a grant from the National Science Foundation, researcher Dan Shugar from the University of Washington Tacoma traveled with a team to investigate the damage caused by the landslide in the summer of 2016. The terrain and its inherent hazards and shallow areas posed significant challenges for both the team and the technology they would use to survey the region.

Shugar's team, equipped with a new ruggedized Teledyne Oceanscience Z-Boat 1800-RP remotely operated unmanned surface vehicle, set out on an expedition into the affected area. The goals of that trip were to map the fjord floor with multibeam sonar and other seismic geophysical techniques that would allow them to see below the surface to determine the thickness of the landslide debris. Along with Shugar were a large group of scientists from Columbia University, the National Park Service, University of British Columbia and elsewhere.

The team's plan was to map the submarine deposits with the UW-Tacoma's Z-Boat 1800 RP named 'Jökull' (Icelandic for glacier) with help from Jeremy Venditti, a professor from Simon Fraser University in Canada, and Doug Bonno, an undergraduate student at UW Tacoma. Also on site was another much larger boat, the USGS Gyre, carrying larger instrumentation aboard including a Teledyne Reson T50 and a couple of seismic systems. The Z-Boat was equipped with a Teledyne Odom Hydrographic MB2 multibeam sonar and an SBG Ekinox-D INS, which gave the team Real Time Kinematic (RTK) position as well as heave, pitch, and roll of the vessel. The RTK data were being broadcast from a Trimble R10 base station that Shugar's team brought on the excursion. Shugar's team performed some velocity corrections and CTD measurements with an AML Oceanographic MinosX instrument. Each day, they set up a makeshift office, which was comprised of a small table with a couple of chairs set on top of bouldery landside deposits on shore. A field laptop, power supply with solar panels, and radio antennas was used to communicate with the Z-Boat. The equipment was all powered by batteries, requiring the researchers to work efficiently in the wilderness.

The Z-Boat proved to be a useful tool, dodging icebergs and getting into areas too dangerous for the larger ship. "The Z-Boat was such a great tool for this particular project. We were working on a gigantic landslide in very steep terrain in front of a calving glacier, which is a pretty hazardous place to be around, so you don't necessarily want to have a vessel with people aboard in this kind of environment. The slope that collapsed is potentially unstable even now and so another landslide could occur. You don't want to be too close to the calving face of the glacier because if a big piece comes off, it could generate a wave that might flip your boat," explained Shugar.

"The Z-Boat allowed us to get into these otherwise inaccessible locations that the larger USGS boat wasn't comfortable doing, either because it was too dangerous or potentially too shallow. We were able to fill in the gaps where the big boat didn't really want to go," said Shugar.

Having the Z-Boat greatly increased the team's chances of collecting important data and gaining access to remote locations.

"As a geoscientist that studies geohazards in particular, the ability to go where we have never been able to go or map what we have never been able to map, with this kind of resolution, in these extreme environments and remote areas, is a tremendous advantage. Not only can we answer more profoundly scientific questions than we've been able to in the past but also we can ask entirely new questions," concluded Shugar.

www.teledynemarine.com

TRIAXUS

Towed oceanographic data acquisition system

Multi purpose vehicle

Lightweight and rugged hydrodynamic design

Powerful control system

Flexible and high payload capacity

Multiple gigabit ethernet channels

MacArtney global solutions

Denmark | Norway | United Kingdom | USA | Canada
France | Netherlands | Germany | Australia | Singapore | China

Fiber-Optic Connector Technology for Oil & Gas Ops

By Jeremy Calac and Michael Mulcahy

Fiber-optics (FO) technology is finding new uses in subsea applications. Fiber allows longer transmission distances and higher data rates than copper — a fortuitous development, as offshore drilling moves to deeper depths. Petroleum exploration and production are also becoming smarter, as operators pursue real-time information and analysis of both the individual well and the entire production chain from well to topside or land-based platform. Compared to copper, the high bandwidth of fiber allows richer data streams and much longer step-out distances (i.e., distance between subsea installation and surface facilities). Umbilical cables can easily reach lengths of 10-15 km, while pipeline cables, used for sensing, can extend to 40 km.

Optical fibers also make superior distributed sensors.

Figure 1:
TE Connectivity's SEACON 24/48 Channel HydraLight Wet Mate connector for optical subsea distribution systems.

Photo: TE Connectivity

TELEDYNE CARIS
Everywhereyoulook™

HIPS Essential

processing **software** for bathymetry surveys

Introducing the new HIPS™ *Essential* application, tailored for use by Ports and Waterways and small survey companies. HIPS *Essential* will meet your standard multibeam processing workflow requirements with quality assured and a cost effective price. As part of the HIPS and SIPS™ family, HIPS *Essential* maintains the robust nature you have come to expect from CARIS products and is easily expanded to meet your growing needs.

Visit stand N10 at Ocean Business 17 to find out more.

caris-info@teledyne.com | www.teledynecaris.com

TELEDYNE CARIS

Changes in pressure or temperature modify the backscatter profile, allowing highly accurate measurements by monitoring the backscattered light. Because the velocity of light in a fiber is well understood, the backscattered light reveals information on both the magnitude of measurement and its location along the length of the fiber.

Since each fiber is smaller and more capable than a copper cable, the number of fibers an umbilical cable can accommodate is also increasing, from a dozen or fewer today to 24 or even 48 fibers in the near future. Figure 1 shows the TE Connectivity's (TE) SEACON 24/48 channel HydraLight wet-mate connector for optical subsea distribution systems.

Such advances in technology have increased interest in optical connectivity. Subsea connectors, for either copper or fiber cables, face an extremely harsh operating environment characterized by high pressure, temperature extremes and corrosion-

Figure 2:
Insert top left: TE Connectivity DEUTSCH Fiber Optic Feedthrough System for Horizontal XT.

TE Connectivity DEUTSCH Fiber Optic In-Well Wet Mate Connectors

Photo: TE Connectivity

Become a part of COVE - Centre for Ocean Ventures and Entrepreneurship, Halifax, Nova Scotia, Canada.

COVE is a global centre for ocean businesses and technology commercialization with offices, light industrial space, and shared workshops and marine facilities on the deep water port of Halifax, Canada. We welcome members, occupants and businesses to become part of our collaborative environment.

For more information and to submit your response, visit: **www.coveocean.com**.

COVE centre for ocean ventures & entrepreneurship NOVA SCOTIA, CANADA

friendly seawater. Despite operating in such adverse working conditions, a connector must be absolutely reliable throughout its design life of 25-30 years.

On one side of the equation, industry requires growing fiber count, and on the other side lower cost and higher reliability. The objective is to have a connector that is well-balanced between these seemingly "opposite" requirements. This is the reason why FO connector designers continuously innovate in terms of design and integrated optical technology. In the new offshore oil and gas market environment, they are committed to bringing FO connector capability and cost-effectiveness as close to each other as possible.

Drymate connectors are familiar to users of military/aerospace circular connectors. FO drymate connectors can be installed either within a module or between modules that have been assembled on-site. They are designed for topside mating in an atmospheric environment, although they withstand subsea water and pressures while mated. The standard coupling of each half – ensuring sealing integrity of the mated pair; is performed manually via a threaded coupling ring.

In subsea FO wetmate technology, typified in the second-generation HydraLight connector, the crucial fiber-to-fiber underwater union is accomplished while both halves of the FO termination are protected from contamination by seawater, sand and silt, because the mating process occurs in an enclosed, separate, oil-filled, pressure-balanced chamber. This pressure balancing system allows the connector to operate without being affected by the pressure, in contrast to most drymate connectors, which have to withstand pressure differential due to having an atmospheric-pressure internal cavity.

Smaller systems benefit from fiber optics. More compact, lighter, highly modular subsea drilling and production systems are the order of the day. They are easier and less expensive to install. Even though an optical fiber weighs much less than a comparable copper wire, there are practical limits to how small a connector should be. A subsea wetmate connector that will be deployed by a remotely operated vehicle (ROV) must be large enough to be clearly seen by ROV cameras, and sufficiently robust to be mated/unmated without damage by ROV manipulators. In this case, ROV-mateable connectors may have generous lead-ins to guide the mating halves together.

Connecting Traditional Packaging to Subsea Applications

To a great extent, subsea fiber optic connectors use new ways of packaging tried-and-true technologies, rather than radically new and unproven approaches. TE Connectivity Marine Oil & Gas adapts technologies that were well-established for telecom, network, aerospace and military applications to subsea applications. Subsea connector technology relies on ultra physical contact (UPC) and, more recently, angled physical contact (APC) for better performance (especially with sensing systems) of termini based on a ceramic ferrule, a well-understood technology dating back 40 years and the beginning of fiber optics.

During the last decade, alternative optical connectivity technologies have been developed and proved their reliability from both manufacturing and application perspectives. Some approaches use a non-contacting interface to provide higher durability and tolerance to rough handling, with a small penalty in optical performance. Others provide a high-density, multi-fiber connection to save space and weight for high-fiber-count systems, at the expense of some complexity at the connecting interface and pre-alignment mechanism.

In another interesting connectivity technology development, a bare fiber cleaved tip has been repackaged into a downhole wetmate connector. This epoxy-free and ferrule-less technology offers both greater tolerance to high temperature and a lower-profile dimension in order to fit into a tight downhole casing. Figure 2 shows FO wetmate connectors developed for subsea trees and downhole applications.

Depending on the subsea and marine application and type of sensing required, each of these optical-interface technologies has its place. The main challenge is to adapt these technologies optimally, in order to create a cost-effective solution meeting installation, deployment and maintenance needs.

Industry needs connectors to function reliably when installed subsea and downhole in a well for reservoir surveillance and improved oil recovery. High-temperature wells (e.g., >150°C), where electrical sensing systems face some limitations, were targeted early on for deployment of FO sensing systems. Over the years, FO sensing gained interest among operators, not only for the ability to withstand very high temperatures, but also for the quality and the amount of data retrievable from the wells.

Most operators introduce next-level FO capabilities as part of a natural progression in their field development. As marine oil and gas exploration and production venture to ever-increasing depths, with consequently more robust fiber-optic connector operating pressure and temperature requirements, industry challenges evolve to keep pace, and a collaborative approach with customers and partners is key for subsea FO connectivity design. It is always desirable to exceed technical requirements, but it is much more important to exceed customer expectations in term of cost, operability and reliability.

Future Implications

Long transmission distances, high data rates, lightweight, small size, distributed sensing—fiber optics brings together so many capabilities important to improve efficiency of marine offshore exploration and production. The technological breakthroughs of optical fiber connectivity can create a bright future with the possibility of developing and producing with higher performance at lower cost and unlocking new resources.

UUV Innovator

Riptide looks to outfit a growing market

Smaller UUVs

By Justin Manley, Just Innovation and Jeff Smith, Riptide Autonomous Solutions

Six micro-UUVs ready for delivery

Photo: Riptide

Unmanned Undersea Vehicles (UUVs) trace their history to the Special Purpose Underwater Research Vehicle (SPURV) developed by the University of Washington's Applied Physics Laboratory in 1957. While the UUV was conceived decades ago it was the Remotely Operated Undersea Vehicle (ROV) market, with offshore oil and gas providing a significant driver, which initially saw significant technical and product developments.

It was not till the late 1980s and early 1990s, that UUVs began to be noticed again.

New, lower cost, autonomous vehicles leveraging the latest computer hardware and processing, as well as sensors from ROVs, began to appear in academic research labs. During this period large U.S. defense contractors such as Boeing, Lockheed Martin and Northrop Grumman led various Navy program development efforts. As the 2000s opened, technologies from the academic labs and research institutions transitioned to start-ups. These firms began to deliver UUVs as products. While volumes were small the market for U.S. and international defense, scientific and commercial clients was becoming viable.

In the past decade the market has grown steadily. U.S. Navy multi-year programs for both UUVs and long-endurance gliders had significant impact. Meanwhile commercial oil and gas expanded to deeper fields where large UUVs compete well in surveys, such as those for pipelines or cable routes. Also during the past decade environmental monitoring requirements have expanded. Fortunately scientific users inspired innovation in smaller UUVs and increased adoption of both long-endurance gliders and compact, relatively affordable UUVs. The market became robust.

To date, military use of UUVs has largely been driven by Explosive Ordnance Disposal (EOD) requirements. While these operations have used smaller vehicles, especially systems of roughly 12 to 21 inches diameter with lengths up to 20 feet, the current trend in the U.S. Navy is to look to even larger, more capable and costlier UUV platforms that can store enough energy to operate for longer periods. This is most notable in recent interests in large displacement UUV (LDUUV) and even extra-large displacement UUV (XLUUV) concepts.

Throughout this history, UUVs have typically evolved slowly, driven by a combination of bureaucracy and risk tolerance that was not always friendly to agile and innovative technology development. Product development cycles could be measured in years and even commercial delivery times are typically many months. Typically the cost of a basic UUV, without payloads, was at least equal to the cost of the sensors required

to complete meaningful missions, if not multipliers of the sensor costs. The combined platform and payload budget can quickly exceed $1 million, even for these medium sized platforms. Another notable feature of the traditional UUV market is a general trend toward larger sizes being necessary to provide greater range. Recent developments in UUV technology are changing the field.

Micro-UUV Technology is Flexible and Fast

In 2015, several veterans of the conventional UUV sector set out to change the dynamics of the industry, founding Riptide Autonomous Solutions. Riptide's first product was the micro-UUV, a new, flexible, open source autonomous undersea vehicle that provides a state-of-the-art, low cost solution suited for developers of autonomy and behaviors, power systems, subsea sensors, and other new payloads. The micro-UUV features open hardware and software interfaces giving users a reliable and robust 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, reducing the vehicle's hydrodynamic signature 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.

In contrast to typical proprietary architectures, the micro-UUV features a flexible software architecture leveraging a large amount of open source software. The goal is to foster an active and vibrant user community who will be provided with source code under a standard open source license. 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 is providing code for the Arduino and Beaglebone Black development platforms, as well as support for the MOOS-IvP robot control engine. Future releases are planned to include support for ROS (the Robot Operating System) and streamlined user interfaces.

In addition to embracing current software development

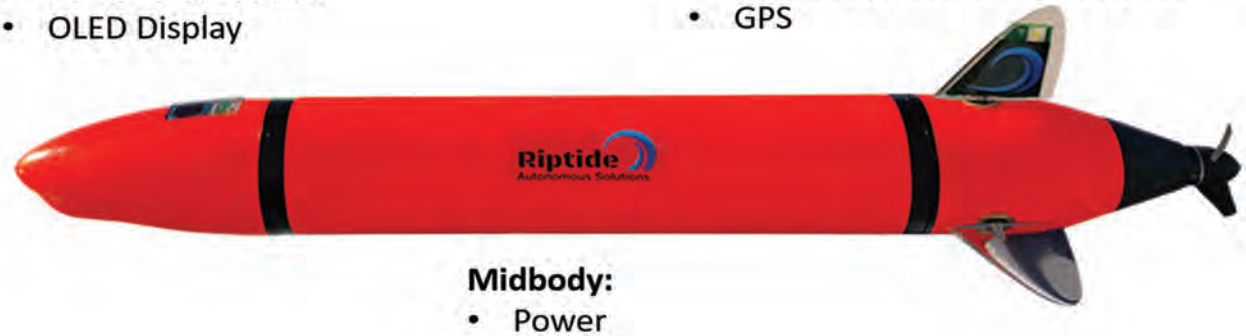
A Typical Alkaline Battery Pack for a Micro-UUV

Photo: Riptide

The layout of a micro-UUV

Nose:
- Vehicle Sensors
  - Pressure, Temp, Altitude, IMU
- Mission Processing
- Power Distribution
- OLED Display

Tail:
- Propulsion
  - 350W External Motor (3000m rated)
- Vehicle Control
- Communications (WiFi Standard)
- Emergency Systems
  - Dropweight / LED Strobes
- GPS



Midbody:
- Power
- Payload
  - Dry or Flooded Volumes

Photo: Riptide

trends the micro-UUV has been developed using a large quantity of 3D printing. This has enabled affordable and quick evaluation of numerous design considerations. This rapid manufacturing capability has also enabled Riptide to quickly field production vehicles. This approach is not just for engineering models. It is delivering product capable of withstanding the pressures and harsh environment of UUV operations. The use of modern design and manufacturing techniques has also enabled the development and delivery of numerous micro-UUV configurations. A variety of sensors, as well as wet and dry payload bays, have been rapidly developed and successfully delivered. All has occurred within 15 months of the first conceptualization of the product.

The micro-UUV was designed for low logistics. The standard configuration uses 144 alkaline AA batteries just like a television remote control but in greater quantity. They can be swapped out in minutes. The use of alkaline batteries avoids many of the limitations and restrictions with shipping, safety, and government certification of lithium batteries, while providing enough energy to run these efficient vehicles for a day or more, depending on operational speed and payload power. In addition to flexibility in shipping, deployment is simplified with a vehicle of such small size. There is no need to rely on large, expensive surface vessels. Operations from the dock, from dinghies, and even from paddleboards are possible.

The development of the micro-UUV has been remarkably quick, and users have been equally fast to put it to the test. Several key milestones in 2016 were driven by U.S. Navy interest.

In March 2016 the first three production micro-UUVs were delivered to SPAWAR Systems Center - Pacific. These vehicles were configured with a flooded payload module to enable rapid payload development and demonstration.

In July 2016 six micro-UUVs were delivered to the Naval Surface Warfare Center Panama City Division (NSWC PCD). These vehicles were configured with a dry payload volume that will enable the Navy to test various new sensor systems with these small flexible vehicles.

During the week of Aug. 22-26, 2016 Department of the Navy scientists and engineers collaborated on Government Acceptance Testing (GAT) of the micro-UUVs at NSWC PCD. Technical personnel from NSWC PCD, Naval Undersea Warfare Center (NUWC) Keyport and Space and Naval Warfare Systems Center Pacific (SPAWAR) worked to evaluate the systems against the U.S. Navy's requirements for specific mission areas, including mine countermeasures.

A bench test was conducted to ensure sensors and other aspects of the UUVs worked properly and during the latter part of the testing week, the engineers operated and tested the UUVs in the intended salt-water environment.

The goal of this collaboration was to better understand the product and how it applies to the science and technology work done at NSWC PCD, as well as other Navy labs.

The GAT concluded that the micro-UUVs will be beneficial in a variety of research and other missions that would be more difficult for larger UUVs. Currently the systems do not match the capabilities of Fleet vehicles but once testingis complete, the engineers can reconfigure the systems to meet their evolving needs.

Current Fleet vehicles and most commercial UUVs offer a very low level of autonomy, in which every single action must be programmed in advance. With their new micro-UUVs NSWC PCD scientists and engineers are experimenting with higher levels of autonomy and moving toward communicatingwith a UUV to teach it how to survey the area on its own without laborious step-by-step advance programing. Navy researchers are looking forward to using the micro-UUVs for autonomy research and believe the flexibility and ease of use of this new tool will rapidly advance new ideas for consideration by the Fleet and wider UUV user community.

While the current micro-UUV capabilities are exciting it is the potential to dramatically expand their range and endurance, without increasing size, which will truly disrupt the UUV market.

Currently 144 alkaline AA batteries are used in a standard micro-UUV. This provides approximately 300 Wh which, with no payload, running at peak efficiency gives the micro-UUV a range of a little more than 100 nautical miles in 36 hours. This presumes an operating speed of 2.8 knots. At 0.5 knots the same vehicle configuration can run for three days. With a suitable compact side scan sonar operating, at optimal efficiency the vehicle has a range of 72 miles in 20 hours at a cruise speed of 3.6 knots.

This performance is adequate for many applications, but it can be improved upon. Through an exclusive partnership with Open Water Power Inc. the micro-UUV will pioneer the use of aluminum seawater batteries. This new technology harnesses the energy of a chemical reaction between seawater and carefully treated aluminum alloys. The result is an inherently safe energy storage solution with a dramatic increase in energy density.

With the use of this new battery technology the endurance of a micro-UUV can be extended well over 10 times the current production capability. An ability to survey up to 1,000 linear miles with side-scan sonar, with a hand-held vehicle, is nearly here. Like the micro-UUV the Open Water Power solution has received significant interest from the U.S. Navy and is in its early phases of delivery. Prototype demonstrations in the micro-UUV are anticipated during the summer of 2017.

The micro-UUV has a starting price of $10,000. This de-

gree of affordability will allow for an even greater expansion of the market, reducing the barriers to entry for vetting new sensors and new applications. It also enables larger quantities of vehicles to be cost-effectively deployed. Coupling this highly affordable solution with a significantly longer persistence made possible by Open Water Power's breakthrough in energy density will allow for even greater capabilities to be fielded. Power hungry sensors can be tested from smaller, lower logistic platforms. Longer endurance missions will require advances in autonomy that can more affordably be validated without risking high cost systems. In a domain where high costs and short mission durations have been commonplace, Riptide is offering game changing alternatives to these past obstacles with its first product, the micro-UUV.

Relative Performance of the Micro-UUV with Different Batteries Options

Energy Option	Predicted Endurance @ 2 knots (per foot of battery volume)
Alkaline	30 hours
Lithium Ion (Rechargeable)	36 hours
Lithium Ion (Primary)	100 hours
Open Water Power	400 hours

Ben Kinnaman
CEO and President
Greensea

Greensea is redefining the connection between

Man & Machine

Ben Kinnaman and his Greensea Systems crew are on a mission to have its software backbone become the standard of subsea robotics and the marine industry, bringing a paradigm change in the relationship between man and machine. From his Richmond, Vermont headquarters, he explains.

By Greg Trauthwein

To kick things off, can you share with our readers how you came to found and own Greensea ?

I grew up on the Outer Banks of North Carolina; I grew up on the water. My first job was at 13 working on fishing boats and sailboats, and then I started diving. I went to school and earned an undergraduate degree in physics from Davidson College in North Carolina. I earned my undergrad in Physics – Computational Physics, and following graduation I went right offshore as a diver, working as a salvage diver for a number of years, moving to deep ocean salvage.

How did you work help to shape your career?

As a diver I was a contractor, so I worked for a lot of (the salvage companies). And then I worked for Phoenix International, (working) ROVs and AUVs on search and salvage, mostly deep ocean. I wrote my first computer program when I was eight, and combined with my background in physics and computers, I certainly had an interest in the technology behind (vehicle operation). I developed a particular interest in what held it all together, and I think, uniquely, from an operator's perspective, how it was applied in the field to get the job done. So I started working on a concept for a software architecture for (vehicle) control and navigation.

Considering the complexity of the machines working undersea, isn't this already a standard?

Our industry is unique in the robotics world, and really in the machine world, in that we are blissfully without standards. If you look through the subsea industry – and largely through the marine industry – standards are very hard to come by. There were a few standards that have been adopted in shipboard interfaces. But when we start moving to subsea, robotics, diving and submersibles, there really aren't any standards. So that simple problem was really interesting to me. And when I was working offshore (around the year 2000) is when we started seeing a big step in (vehicle) technology.

What exactly do you mean?

We started seeing this kind of 'step' function in technology coming into the field. AUVs were becoming viable (for commercial operations), but it was 'step technology.' As an operator, with each new capability we would get another black box, and we would take this black box and put a new computer in the rack and we would add a new monitor, and then we would integrate this new sensor onto this ROV.

But it really wasn't integrated, it was just bolted on. So at the time it was just more and more black boxes; it was a fascinating problem. So I started working on the concept of the software architecture that would knit all of that together, really focused on the operator's relationship with this technology.

Did you stay offshore while working through the problem?

No, I left offshore and I moved into engineering. I went to graduate school at Johns Hopkins. I went to Hopkins to focus on control theory and robotics. My Master's Degree is in Mechanical Engineering through Hopkins' Robotics and Control program.

Following your Masters, what was your next move?

Not too long after I left Hopkins, I was interested in pursuing this control software architecture. It wasn't a great fit for the company I was with, as Phoenix is a service provider. So we started Greensea to develop technology that addressed the relationship between operators offshore and the technology they were using. For the first two years – from 2006 to 2008 – Greensea

Photo: Greensea

Though we are a software company, Greensea is very hardware-oriented. **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.**

focused on developing this core architecture which is called "OPENSEA."

Starting in about 2008, we felt that that we had reached a maturity level with OPENSEA that that required us to start testing, it required us to start getting some blue water experience. From 2008 to about 2013 we took on several large projects a year. Prime contractor-type projects or science projects –big integration projects. So during this period, Greensea was largely characterized as an engineering services company.
But our intent for OPENSEA all along was to develop a product for the offshore industry that could integrate these disparate technologies into a common operating platform, and ultimately, make the operator's job a little bit easier and a lot more effective. And in 2013, we felt that we had reached a maturity level of OPENSEA that would enable us to start productizing this technology. So for the next couple years, we really listened to the community to figure out how to go to market with the technology.

And what was the strategy from the outset?

Marybeth Gilliam joined us at the end of 2014 to help me take this to market – to figure out the market entry for this technology and how we were going to be successful in the market with OPENSEA. Today Greensea is a provider of products and technologies based on OPENSEA in five sectors of the marine industry: manned and unmanned subsea, manned and unmanned surface, and diver systems.

So in a nutshell, what is Greensea today?

Greensea is a software company that develops technologies aimed at bettering the relationship between operators and their equipment.

When you started the company 10 years ago was it just yourself?

It was myself and another senior engineer for first year or two, and then we brought on a technician. My wife was instrumental in making the company a company. Like so many startup stories, I was consumed writing OPENSEA, and my wife was holding the business together and making it happen.

What was the main challenge as a start-up?

Though we are a software company, Greensea is very hardware-oriented. 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.

So how did you settle on Richmond, Vermont, as the place for Greensea?

Lifestyle and a place to raise a family. When we decided to start the company we had an opportunity to make some big decisions, and my wife was fortunate enough to have a career that would let her move. We knew we wanted to start a family, and we wanted an idyllic place for a family to raise kids. Vermont really impressed me because there was a growing technology environment, there was a growing small business tech environment. But there was an awful lot of support showing from state government and local government and local infrastructure for small business. So off we moved to Vermont.

I know we addressed this briefly, but again what was the greatest challenge in the first few years?

I think the greatest challenge was, and will continue to be the market. More specifically, the market adoption of a really advanced technology in an operating environment that had traditionally managed so many risks by avoiding technology.

The Maritime Industry's Largest
Social Media Presence

Maritime Reporter is a member of the Marine Media Network of websites, publications, and social media sources for news, editorial and information including the Maritime Network, the commercial marine industry's largest dedicated Linkedin group.

63,864
Facebook Page Likes

128,718
Linkedin Group Members (industry's largest)

27,505
Twitter Followers

MARITIME REPORTER AND ENGINEERING NEWS

THE MARITIME NETWORK

@ShipNews

Also part of the Marine Media Network

Page	Likes
Marine Electronics	34,849
Marine Technology Reporter	57,604
Maritime Global News	27,015
Maritime Jobs	46,961
Maritime Logistics Professional	31,807
Maritime Propulsion	23,378
Maritime Reporter & Engineering News	63,864
World Energy News	51,176

All stats from 02/14/2017

Photos: Greensea

What do you mean?

Just think about ROV industry; it is an incredibly high-risk environment. We're working at depths greater than 10,000 ft. at a significant cost per day, so we have to manage risk. Traditionally, we (the industry) managed these risks by keeping things simple. But then we started having this mismatch of requirements and risk management. So on one hand we were managing things by keeping things simple; on the other hand we were having these growing set of operational requirements for positioning, quality of data, time onsite, cost mitigation and cost management among other things. So we started having all of these requirements that (could only be met by) injecting technology. So now we're injecting technology with amazing new capabilities, but we weren't addressing this fundamental premise to "keep it simple." And that really was around how the operators work their vehicles. The operator – the point where the operators met the technology – we didn't address that.

How does Greensea aim to rectify the situation?

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. So take mine countermeasures for example. We want to get these operators away from worrying about flying a vehicle, to focus on mitigating a mine and mitigating a risk offshore. But if they keep trying to manage this onslaught of 'black boxes' and bolt-on technologies, consuming their bandwidth and making the operator the integration point of all of these technologies, we are not going to move this industry forward. We are proposing a big paradigm shift in how operators use technology, how operators use vehicles offshore. And a big paradigm shift in an operator's relationship with their systems.

Quite a challenge ...

It is. The technology is tough, but that's not the biggest challenge. The technology challenge is the kind of challenge that gets engineers out of bed every morning. But moving that technology effectively offshore, listening to the operators … ultimately the technology and software is only as good as the user says it is. Listening to the operators and figuring out how to really address their operational issues is the hardest part.

When you look at the company today versus when you started, how is it most the same and the most different?

The company recently turned 10 years old and today we are at an inflection point. Our first 10 years were spent listening to operators and developing technology, creating products out of the OPENSEA framework. This is a small industry and we are proposing a big change in the way operators work with their equipment. We have one chance to get this right. So we've spent 10 years listening to operators and developing

Faces of Greensea

Ben Kinnaman has built a tight team of about 20, including (starting far left): Marybeth Gilliam, Chief Marketing Officer, VP Sales, was brought in a few years ago to help bring the Greensea product and brand to market

Heath Hescock, Robotics Engineer and Alden Fredericks, Engineering Technician, test NAMJet iNAV, a Greensea vessel control system.

Colin Riggs, (top center) Senior Robotics Engineer, Product Development Manager.

Jason LaShelle, (bottom center) Production Manager, gets SeaBotix SmartFlight 2.0, a Greensea system, ready for testing.

Shay Osler, (right) Robotics Engineer, after product testing on Lake Champlain

this technology, and today we have more than 700 systems in the field. We are at the point where we are growing the company into five segments of the marine industry: Manned and Unmanned Subsea; Manned and Unmanned Surface; and Diver Systems.

(With our platform) an operator can buy a sensor from a manufacturer and plug it into his Greensea system. That is a huge concept in our industry, to provide a core system architecture that allows an operator to integrate any sensor, any device, to integrate new technologies, to integrate inertial navigation and positioning and autonomy.

Our company today is much different than our company was 10 years ago in the sense that we are now really focused on commercial growth. And we are focused on integrating our products into the marine industry, whereas 10 years ago we were focused on technology development.

How are we most the same? We are the same in the sense that when we founded the company, our number one goal was to listen to the operator. And that hasn't changed at all.

What do you consider to be your greatest achievement?

That's tough. I think in a general sense, the realization of a pretty lofty idea 10 years ago and the development of OPEN-SEA. For 10 years we've stayed steadfastly true to our roadmap, and that is unique in growth companies. We have stayed as true and as narrow to our roadmap because I believed that there was a better way that operators could operate offshore, and operators could be using technology. We sketched out a roadmap, and it was through integration and it was through autonomy; using autonomy as a tool for the operators, not to replace the operators but to elevate the operators.

From your perspective, put on a curve acceptance of the attitudes that you're talking about. Where are we today?

The doors have flung open and the clouds have parted, because the operators are asking for it.

Why are the operators asking for it?

How could it not be expected when I look at what I can do with my phone right here. I'm traveling to Florida next week, I can make my plane reservation, I can make my hotel reservation, I can book restaurants, and it's all going to be integrated on my calendar. When I arrive it will remind me that I have

NAMJet iNAV, a Greensea Vessel control system, is tested on a Birdon Marine workboat.

reservations and ask if I want driving directions. That's in my back pocket and everybody has that integration. So if that's how we're managing our day-to-day lives, how can it not be expected in our professional lives.

So how is your company's effort a means to this end?

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. An operator today can put a Teledyne Seabotix vehicle in the water and fly it around and see something of interest on the sonar, double click on it, and then all of their control and navigation is with respect to whatever they clicked on.

Is there one particular project – that you can talk about – in your mind that stands out that best illustrates the concept which you seek to deliver to this market in whole?

I think the integration of this technology in both inspection and observation class vehicles and diver systems is probably the clearest, best examples of such a huge benefit and really recognizing the value of this technology. To date, I think the clearest and best, most concise example of realizing this goal and the potential is the diver nav system, the diver propulsion system that we do with STIDD Systems. (See related story pg. 43).

When we have a conversation on the 20th anniversary of Greensea, where do you envision this company will be?

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. We are certainly growing aggressively right now, but we're preserving our culture, preserving what makes Greensea unique. So I think 10 years from now, our conversation will be quite similar: it will feel the same at Greensea, it will kind of look the same at Greensea; but you will see a lot more Greensea when you travel around the world.

"When I started the company, literally the first day when I left the attorney's office after signing the incorporation paperwork, I got home and I put on this workshirt."

The Greensea Workshirt

Ben Kinnaman, founder of Greensea, speaks passionately regarding the corporate culture he and his team have built, and aim to maintain, as the company expands. Through all of the high tech solutions the company delivers with its software backbone as it seeks to enhance the relationship between man and machine, perhaps no other element better embodies the Greensea philosophy than the ubiquitous Greensea workshirts worn by its entire crew. Kinnaman explains their significance.

"When I started the company, literally the first day when I left the attorney's office after signing the incorporation paperwork, I got home and I put on this workshirt. The reason I did it: I wanted to make sure that as Greensea developed this technology, when all of these super-smart engineers around here get themselves dressed in the morning and look at each other, that they're seeing their end user – that they're seeing some guy in the field wearing a uniform – like our armed service vendors and like our defense customers. We are wearing a work shirt for our commercial customers and our commercial end users.

And I wanted to make sure that every single day there was a direct relationship between the technology that we are developing, our engineers and their end users.

That defines our culture."

STIDD Diver Propulsion Device (DPD) & Greensea's

"Get Me Where I Want to Go" System

Greensea's Ben Kinnaman thinks big, delivering solutions that enhance the man/machine relationship, and allowing the human specialist – whether that specialist is a scientist, commercial manager or combat diver – to do their job more efficiently. Greensea's work with Stidd Systems on its Diver Propulsion Device (DPD) is a perfect example.

"That diver has a lot going on – especially a combat diver on a DPD flying underwater at three or four knots," said Kinnaman. "If you ask a combat swimmer 'what do you need to make this mission possible?,'" they are not going to mention a piece of high tech equipment. "They are going to tell you, 'I need to get to Point B, period.' That's our job –to get them there. So we are not building a navigation system; we are not building an autopilot system; we are not building a mission planning system. We're building a 'get me where I want to go' system."

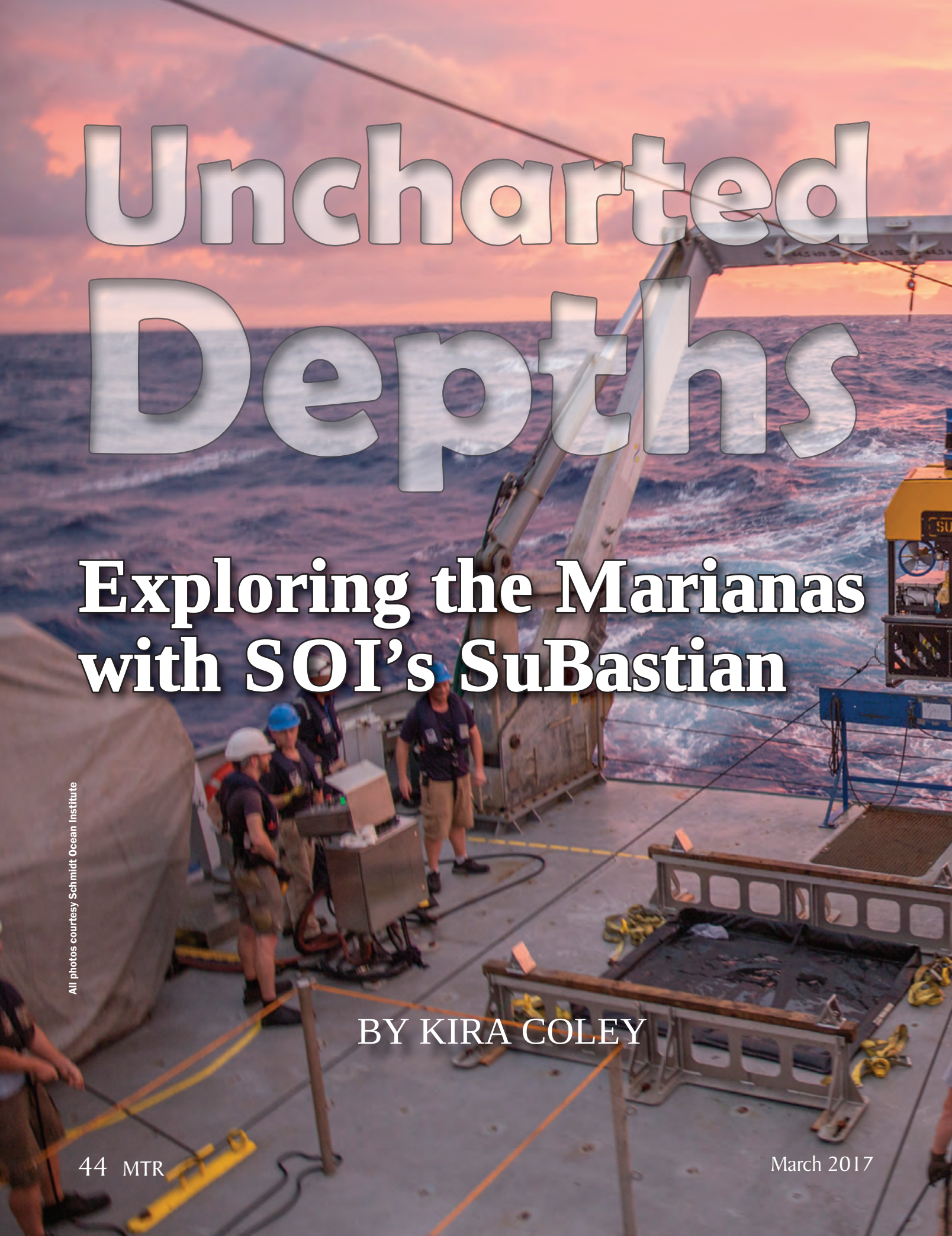
Kinnaman said the engineering challenge is the relationship – how the operator is to use the tools that are behind the scenes – the inertial navigation systems, the autopilots, the mission planning systems and the sonar interfaces. The interface that delivers the operator's requirements is really the hard part, and that's the relationship.

For the DPD Greensea has a number of deliverables according to Kinnaman. "STIDD builds the Diver Propulsion Device, and there is an element to the DPD called the R-NAV 2, a navigation system, a computer that plugs into the DPD. We build R-NAV 2 that runs our software.

Inside of it there are four principle components, all of which are standard products for Greensea. We have an inertial navigation system, we have a mission planning system, we have autopilots and we have a sonar interface. And what fuses all of those together is this workspace, this unified operating environment which the operator uses, he's got a small screen and he has two strain gauges under his thumb that he operates this system with while he flies. That's the Greensea deliverable.

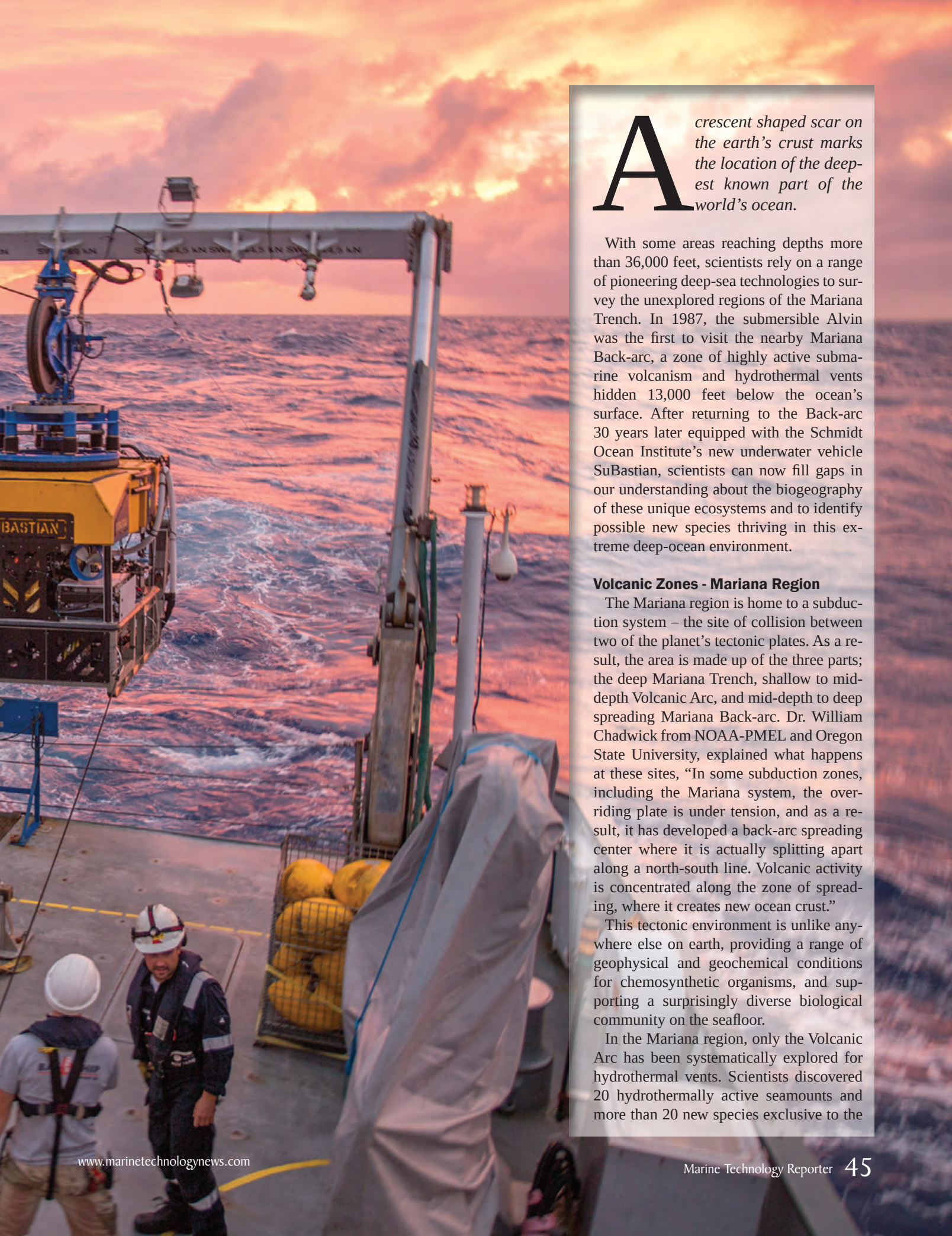
Uncharted Depths

Exploring the Marianas with SOI's SuBastian



All photos courtesy Schmidt Ocean Institute

BY KIRA COLEY



A crescent shaped scar on the earth's crust marks the location of the deepest known part of the world's ocean.

With some areas reaching depths more than 36,000 feet, scientists rely on a range of pioneering deep-sea technologies to survey the unexplored regions of the Mariana Trench. In 1987, the submersible Alvin was the first to visit the nearby Mariana Back-arc, a zone of highly active submarine volcanism and hydrothermal vents hidden 13,000 feet below the ocean's surface. After returning to the Back-arc 30 years later equipped with the Schmidt Ocean Institute's new underwater vehicle SuBastian, scientists can now fill gaps in our understanding about the biogeography of these unique ecosystems and to identify possible new species thriving in this extreme deep-ocean environment.

Volcanic Zones - Mariana Region

The Mariana region is home to a subduction system – the site of collision between two of the planet's tectonic plates. As a result, the area is made up of the three parts; the deep Mariana Trench, shallow to mid-depth Volcanic Arc, and mid-depth to deep spreading Mariana Back-arc. Dr. William Chadwick from NOAA-PMEL and Oregon State University, explained what happens at these sites, "In some subduction zones, including the Mariana system, the overriding plate is under tension, and as a result, it has developed a back-arc spreading center where it is actually splitting apart along a north-south line. Volcanic activity is concentrated along the zone of spreading, where it creates new ocean crust."

This tectonic environment is unlike anywhere else on earth, providing a range of geophysical and geochemical conditions for chemosynthetic organisms, and supporting a surprisingly diverse biological community on the seafloor.

In the Mariana region, only the Volcanic Arc has been systematically explored for hydrothermal vents. Scientists discovered 20 hydrothermally active seamounts and more than 20 new species exclusive to the

area. Yet, more than 600 km of the Mariana Back-arc still remain uncharted.

"From the previous exploration, we know that about a third of the seamounts in the Mariana Volcanic Arc are hydrothermally active, but the Mariana Back-arc has never been systematically explored, so we know much less about the activity there. How many hydrothermal vent sites are there in the Mariana Back-arc? Where are they located? What is their chemical input into the ocean? What is their role in the biogeography of vent animals in the western Pacific? Do the different tectonic settings of the Arc and Back-arc affect the character of the vents they host? We should now have the answers to some of these questions, and a starting point for answering the rest," said Chadwick.

Exploring the Back-arc

The first phase of the two-part exploration of the region took place in December 2015 onboard research vessel Falkor. Principal Investigator Joseph Resing, of the University of Washington, led a 27-day mission to the Back-arc with researchers from the University of Washington, Oregon State University and NOAA-PMEL. A vital member of the team was the autonomous underwater vehicle (AUV), Sentry.

The Sentry AUV carried instrument packages consisting of optical and chemical sensors and surveyed systematically for hydrothermally active areas. Three new hydrothermal vent sites were discovered, one being the third deepest in the world.

"At the end of the first expedition, we knew there were vent sites on the seafloor, but we had little or no information about what the sites looked like, what animals lived there or the chemical character of the vents. For that, we needed an ROV," explained Dr. David Butterfield, JISAO, University of Washington, who led the return journey in 2016, along with Dr. William Chadwick, as part of the second phase for the Back-arc mission.

The multidisciplinary team of leading geologists, chemists and biologists aboard Falkor returned with the new 4,500 m capable remotely operated vehicle (ROV) SuBastian, to visually explore and sample the vent sites discovered during the previous cruise.

Chadwick said, "The primary goal was to locate the new hydrothermal vents on the seafloor and to characterize the geology, chemistry of the fluids and the biological communities at the vents. We were exploring a large part of the Mariana Back-arc that had not been explored before, so these are the first observations. We also want to put these new discoveries into the context of what was previously known."

The data collected during the first phase was used to create a map of the area. Now, scientists will combine the map with biodiversity data collected during the recent cruise to better define the relationships between geologic setting, chemical environment and biological communities.

Inside the Control Room

All photos courtesy Schmidt Ocean Institute

The New ROV SuBastian

The return to the Back-arc was the debut scientific mission for the newly built ROV SuBastian. SuBastian was outfitted with a suite of sensors and scientific equipment to support scientific data and sample collection, as well as several cameras, including a high definition 4K video camera.

The Schmidt Ocean Institute was eager to give SuBastian and Falkor the capability to stream live footage on YouTube, sharing the experience and data, with the entire scientific community as well as the public. The organization believes that open sharing of information is critical to advancing the pace of science forward. As such, they plan to live-stream all ROV dives in perpetuity so these videos can be used as a data set. Students also have access to videos in the classroom through a newly developed lesson plan to learn how to do scientific video annotation.

Life among Submarine Volcanoes

It took two hours for SuBastian to reach the Back-arc seafloor at depths greater than 3,500 m. On arrival at the new vent sites scientists, along with a YouTube audience of millions, discovered spectacular chimneys made of sulfide minerals, some up to 30 meters (100 feet) tall, and hot fluid gushing out at temperatures up to 365°C (690°F).

Controlling SuBastian

SuBastian runs on 100% Greensea controls, including the OPENSEA operating platform, and in its first science dive had .005% downtime on over 200 hours subsea. Greensea has been included on all of SuBastian's dives so far, and the company recently signed a deal to support SOI's work in 2017.

Core Software System

- Greensea OPENSEA operating platform

Vehicle Control System Software

- Greensea Balefire Vehicle Positioning/Autopilots
- Greensea Balefire Automated Positioning
- Greensea Balefire Sonar Positioning

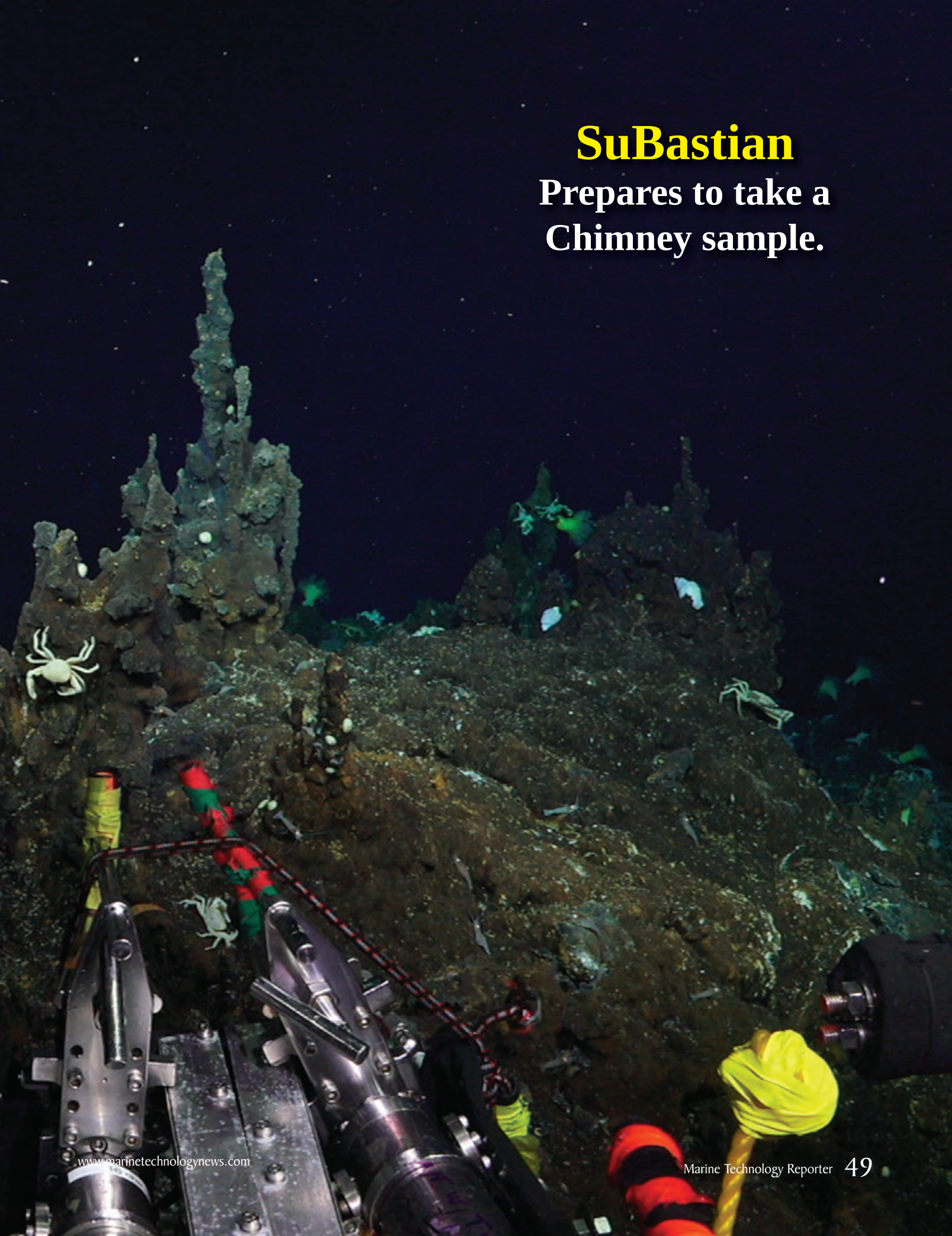
Operator Interface

- Greensea Workspace Mission View
- Greensea Workspace Integrated Video View
- Greensea Workspace Integrated Sonar View with Target Tracking

ROV Control & Telemetry Hardware

- Greensea Custom Design and Build

All photos courtesy Schmidt Ocean Institute



SuBastian
Prepares to take a Chimney sample.

Subastian Goes to Work

SOI's new ROV is a powerful tool to help scientists discover the secrets housed within the ocean deep.

All photos courtesy Schmidt Ocean Institute

The chimneys were covered with a range of animals, including "hairy snails", shrimp, crabs, mussels, limpets, squat lobsters, anemones and polychaete worms, some thought to be newly discovered. Although the vents are separated by long distances up to 100 miles, these new observations suggest that the Back-arc sites are long-lived and have biological "connectivity" between each location. "One of the main discoveries was that all the known Back-arc sites in the Marianas have the same animal species, and many of them are endemic – they are found nowhere else on the planet! That means they evolved into distinct species in the Back-arc and are specifically adapted to that environment," said Chadwick, "Biological connectivity means that since we find the same animals at all the Back-arc sites that they must be able to disperse and colonize between sites, since the vent sites come and go. This is amazing, but apparently, occurs through the release of larvae that are carried by ocean currents to new sites. This is somewhat like plants dispersing thousands of seeds out over water, and only a few of them eventually finding an island where they can grow. Vent site habitats are like islands of chemosynthetic energy distributed along the volcanic features of the deep sea."

The study also confirmed that the Back-arc ecosystems are distinct and different from the nearby Volcanic Arc hydrothermal ecosystems, perhaps supporting the idea that geological and chemical environment play a key role in selecting animal community composition at hydrothermal vents.

Chadwick described a possible explanation behind their observations, "The vent animals are adapted to very specific conditions – probably related to the chemical environment that they need to survive. For example, we now know that there are different but related species in the Volcanic Arc and Back-arc environments in the Mariana region. The Arc and Back-arc have very different chemical environments at their hydrothermal vents due to their very different geology. And likewise, they have different, but related, species living at the vents. It might be that a species from the Arc, does not – cannot – live at a Back-arc vent site, and vice versa. In this way, the chemical setting determines the biological community."

The research team believes this hypothesis is the most likely explanation behind their observations of the unique Back-arc ecosystem. Butterfield explained that there is an alternative, "A competing hypothesis is that the great separation in depth between shallow arc sites and deep Back-arc sites prevents the exchange of larvae between the two environments, so their fauna has diverged over evolutionary time, and the sites are no longer connected by larval transport pathways."

"We don't know for sure that Back-arc species could not survive in an Arc environment, and vice versa. That requires more experimentation on the physiology of vent animals and the range of habitat conditions larvae can tolerate. That is partly why we undertook this expedition: to make the observations and collect the samples to identify precisely what animals are living in each environment, and characterize the range of chemical conditions is in each of the habitats where those animals are found."

Throughout 2017, the team will continue to analyze the data and samples collected during the most recent expedition with hopes to advance research on how life thrives on these extreme deep-sea hydrothermal vents.

"We'll be analyzing the data and samples collected during the cruise for many months and probably years, then we'll be using those data to write scientific papers to share the results of our research with the broader scientific community and to the public. Eventually, this may lead to new questions and new research in the Mariana region," Chadwick concluded.

Acknowledgements

- Dr. William Chadwick, NOAA-PMEL and Oregon State University.
- Dr. David Butterfield, NOAA-PMEL and University of Washington
- The Schmidt Ocean Institute
- This research was supported by the NOAA Ocean Exploration and Research Program, NOAA Pacific Marine Environmental Lab, the NOAA Pacific Islands Regional Office, and the Schmidt Ocean Institute

Verification of Next-Generation Subsea Metrology

Better Measurements, Fast

By Gordon Beattie, Survey Innovation Lead, DOF Subsea UK

DOF Subsea, together with subsea technology companies Sonardyne, 2G Robotics and Seatronics (an Acteon company), successfully demonstrated a new underwater surveying technique in December that could significantly shorten the time needed to map underwater structures and offshore sites.

Representatives from across the North Sea energy sector, including senior figures from oil majors, contracting companies and service providers, attended the demonstrations which were held over three days at The Underwater Centre in Fort William.

The event was organized by DOF Subsea to showcase the capabilities of dynamic mobile mapping. The new technique uses a 3D laser scanner fitted to an ROV to create highly detailed, point cloud images of subsea assets and environments. By combining the 3D laser data with precise underwater acoustic and inertial navigation information, it is now possible to generate centimeter resolution engineering models from which accurate measurements can be instantaneously and repeatably captured.

Shared Knowledge & Communication

In conventional marine construction support terminology, metrology is the work done by surveyors and ROV to acquire various subsea measurements,

The worksite

All images courtesy DOF Subsea UK

Partners & Contributions

THE UNDERWATER CENTRE

- Vessel for the study – Loch Sunart
- Support vessel for deployment and recovery – Loch Shiel
- Work class Triton XL WROV
- Facilities for guests from operators and contractors
- HSEQ control

Sonardyne
SOUND IN DEPTH

- Acoustically Aided Inertial Navigation System, comprising:
- SPRINT Inertial Navigation System (INS)
- SYRINX Doppler Velocity Log (DVL)
- Fusion navigation software
- Janus INS Post-processing software
- Micro-Compatt 6 acoustic transponders

2G ROBOTICS seatronics

- ULS 500 Pro Laser
- Scansoft laser control & QC software
- Subsea gyro packages for bespoke subsea target structures
- Key integration cabling

DOF Subsea

- Specially designed and fabricated subsea target structures
- Specially designed modular sensor housing for AAINS and ULS 500 Pro Laser, with Triton XL adapter
- EIVA navigation software
- Exclusive DOF Subsea Metro software
- Dimensional control surveys
- Project management

Structures being loaded

All images courtesy DOF Subsea UK

typically between flanges on separate pieces of subsea infrastructure. These measurements allow precise fabrication of subsea jumpers and spool-pieces.

Traditionally the vessel time to acquire the measurement data can take between six and eight hours per metrology. The adoption of a smart combination of proven technology can reduce data acquisition (and hence vessel) time to around two hours.

Partners DOF Subsea, Sonardyne, Seatronics and 2G Robotics decided upon an open strategy of bringing interested companies together to demonstrate a direct comparison between well-proven acoustic long-baseline (LBL) metrology and the new possibility – acoustically aided dynamic laser mapping using inertial navigation (AAINS).

Acceptance of any new solution in the industry is a staged process, and the first step is often raising awareness of a challenge and its solution. The efficiency demands in the current marketplace provided an opportunity for DOF Subsea and its technology partners to put this event together and bring their solution to light, openly sharing knowledge, performance data and technical conclusions between a multitude of invited contractors and operators in a single event.

The Trials

In late November, representatives of the partner companies descended on The Underwater Centre in Fort William to prepare and conduct trials prior to the demonstration day. Work was planned to take place aboard the vessel named Loch Sunart in Loch Linnhe, kitted out with all of the necessary equipment, including a work-class Triton XL ROV with TMS.

The work site was chosen, southwest of The Underwater Centre pier.

Key metrology and INS technicians visited from Sonardyne in England, equipment specialists arrived from Seatronics in Aberdeen, and laser engineers from 2G Robotics travelled from Edmonton in Canada to observe the study and deliver the classroom sessions to guests.

In three days, two complete metrology solutions (LBL and AAINS) would be mobilized, configured, tested, full data gathering, data processing and reporting.

Days one and two focused on mobilization, ROV integration, sparse LBL array installation, traditional LBL metrology data acquisition and results. On the third day, laser data acquisition began. VIP guests arrived from leading contractors and operators to learn more about the capabilities of the AAINS solution and a deep-dive classroom session into technical aspects of data gathering, processing and analysis from experts in their field who were on hand to share their knowledge.

Preparation and Delivery

Preparation began shortly before mobilization. Each company is an expert in their field, which produced a collaborative working environment with a high degree of cooperation. This can-do approach to problem solving and vigilance for cost saving opportunities contributed to success and is essential in the current financial climate.

Design and fabrication of the bespoke subsea structures was a joint effort between Seatronics and DOF Subsea. Cost efficiency was at the forefront during planning, so the structures were based on existing off-the-shelf subsea gyro boxes. They included temporary additions of yellow circular flanges, horizontal planes, custom targets and bracketry to represent actual and potential measurement points typically on subsea wells, trees or manifolds.

As December approached, the com-

mon goal of delivering a high quality, open comparison of LBL metrology versus AAINS metrology to the industry moved into view.

Friday, December 3

Using Faro Focus laser scanner, a DOF Subsea Dimensional Control surveyor conducted as-built laser scans of the target structures. The scans were processed and millimeter-accurate information relating to the structures was now in hand. Gathering dimensional control survey data introduces significant opportunities for later in this process, specifically new inferred metrology calculations.

The survey control room was initiated and mobilization began.

Monday, December 5

Support vessel Loch Shiel had a DOF Subsea tug pack installed to allow telemetry of position and heading to the survey control room to allow remote tracking of the vessel. Structures were loaded onto the vessel and readied for deployment.

A temporary acoustic long baseline (LBL) array was created up on the seabed around the structures. Sonardyne provided the necessary Compatt 6 LBL transponders which were swiftly deployed by Loch Shiel using a standard subsea basket supplied by Seatronics.

Approximate positions of the compatts were established using Loch Shiel GPS. The purpose of the compatts is to create a temporary, stand-alone high accuracy relative positioning system between (known as the array) removing the need for high accuracy absolute positioning of the compatts themselves.

Tuesday, December 6

Focus was on calibrating/adjusting the array system and conducting the traditional LBL calculations. Depth measurements between the structures were done via the ROV, using handheld digiquartz pressure sensors. Next, baseline measurements were taken between the array and compatts installed in specially-made receptacles in the subsea targets. The array was used to establish accurate positions for the seabed structures. Calculations were done on the raw observed data using Sonardyne Connect software, in addition to verification using DOF Subsea Metro solution.

The following morning, the team was ready to proceed to acquire a comparison data set, delivered by the ROV positioned using the AAINS system, in conjunction with dynamic laser scanning via the 2G Robotics laser.

[Onboard Loch Shiel] Wednesday, December 7

When using sensors such as multibeam sonar or lasers for seabed/asset mapping, it is vital to conduct a patch test. This patch test allowed the survey-

Survey control room

All images courtesy DOF Subsea UK

ors to establish any corrections required to the laser data in three rotational axes – pitch, roll and heading. It is conducted using automatic survey tools and manual interpretation.

The final quality control step was to establish any laser Index Of Refraction (IOR) corrections which may need to be applied to the raw laser readings. This involved flying the ROV with laser over any structures at varying altitudes.

During post-processing, the high-accuracy acoustic position data is combined with the inertial navigation data, hence the Acoustically Aided element of the robust AAINS positioning solution. Without this technique, drift would be a negative factor in the quality of the final position fixes of the ROV.

ROV data acquisition missions (or runlines) were planned, at an altitude of 3m above seabed, to ensure maximum laser coverage over the two target structures being surveyed.

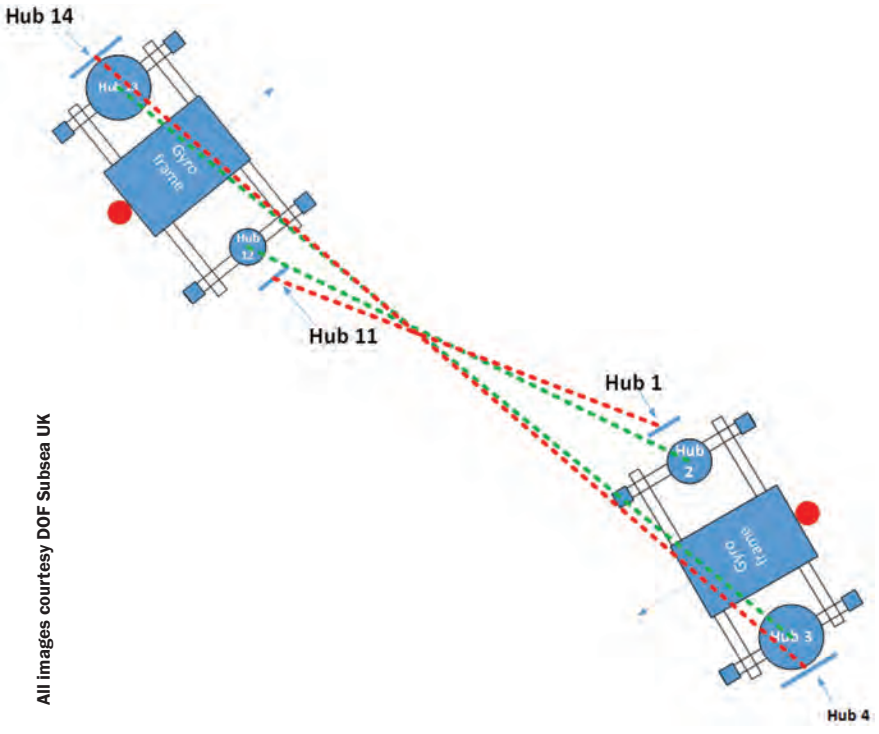
During laser data acquisition, it became apparent that particulates in the water created a significant amount of noise in the laser data which resulted in lowering of the planned altitude. Flying the ROV at a very low altitude over the structures would not typically be required and places extra demands on ROV pilot skill.

Operators monitored the laser data live in a waterfall-type display in the 2G Robotics Scansoft software. This tool provided instant quality control over data and prevented conducting missions with no immediate indication of the quality of data being acquired.

The acquired AAINS data was begun to be processed using the Sonardyne JANUS software and the point clouds delivered by the laser were cleaned and georeferenced.

DOF Subsea Metro software was used to derive unit vector measurements from the final laser scan point clouds. These

Hub Measure Plan



All images courtesy DOF Subsea UK

The Findings

- **Nonintrusive**
No prior subsea intervention was required in advance of metrology, and no subsea bracketry, control spheres or metrology aids are required.

- **Flexible Deployment**
The modular system which was easily fitted to an ROV

- **Time to Survey**
Significant reduction in the time (and therefore vessel cost) needed to gather the survey data in comparison to acoustic LBL

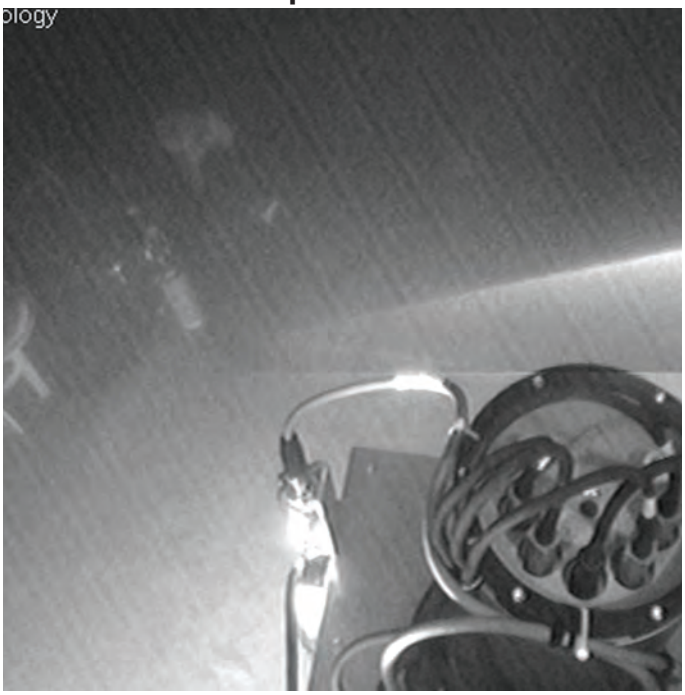
- **Time to Data**
Quick delivery of results offshore; typically within six hours of data acquisition. Data processing was conducted in parallel with array recovery operations.

- **Inferred Metrology**
With prior dimensional control information, hub position and orientation were inferred using laser scan point cloud

All images courtesy DOF Subsea UK

Sensors on board the ROV

Still of ROV laser acquisition



All images courtesy DOF Subsea UK

results via AAINS and laser would be compared to the LBL results.

[Onshore, The Underwater Centre] Wednesday, December 7

Guests from Contractors and Operators arriving at lunchtime were unable to travel by FRC to board the Loch Shiel to witness the laser data gathering due to the high winds on the loch.

In place of the offshore trip, classroom sessions were organized by the technology partners to deliver a real deep dive into the AAINS laser metrology solution. The sessions were informal and designed to involve the audience in asking questions and challenging the technology partners to best communicate the method and logic behind this new technique to provide subsea metrology calculations.

Experts from 2G Robotics, Sonardyne and DOF Subsea answered questions and laid out the various aspects of the metrology, from sensors to point cloud interrogation calculations.

The full end-to-end workflow was traversed in detail, from ROV mobilization through to final report, provided by DOF Subsea Metro survey application.

In keeping with the open culture of the event, all attendees were provided with a full metrology report, copies of all data, photographs and other materials for independent verification.

Direct or Inferred?

DOF Subsea's Metro application supports two types of laser point measurement techniques – direct and inferred.

Direct measurements can be taken typically by taking a circle or plane fit through an easily identifiable section of the point cloud.

The inferred method is made possible by conducting dimensional control surveys of the asset prior to subsea deployment. The results of this survey are used in combination with a 7-parameter shift (scale, pitch, roll, heading, X, Y, Z) to transform any dimension control results into the real world.

This allows establishing a georeferenced XYZ and 3-axes rotation for any point on a subsea structure, even without gathering a laser scan of the part of the structure which is to be measured.

Final Results

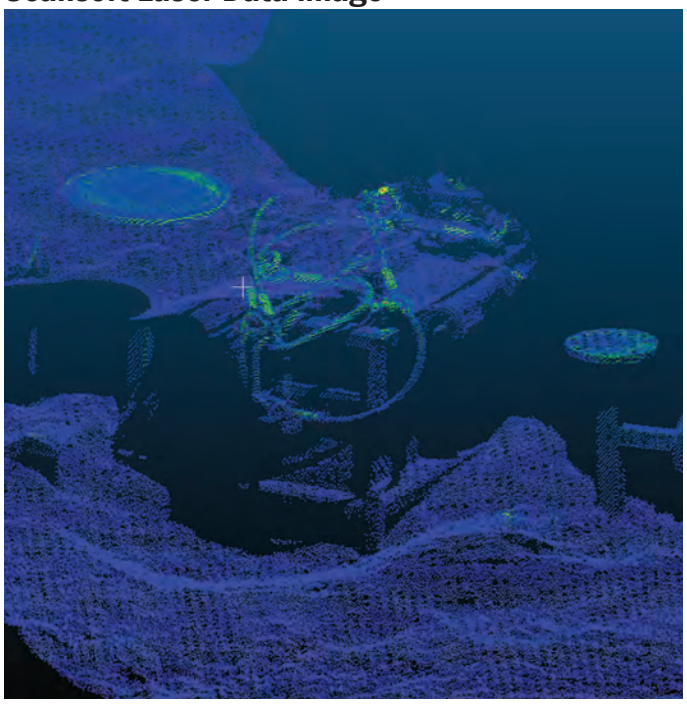
Data collected using the traditional LBL and newer AAINS dynamic laser techniques was processed, and comparisons were:

Overall observed differences between AAINS laser and LBL techniques

- Horizontal Distance: 0.001m
- Vertical Distance: 0.038m
- Bearing between hubs: 0.007°
- Hub Pitch: 0.025°
- Hub Roll: 0.029°

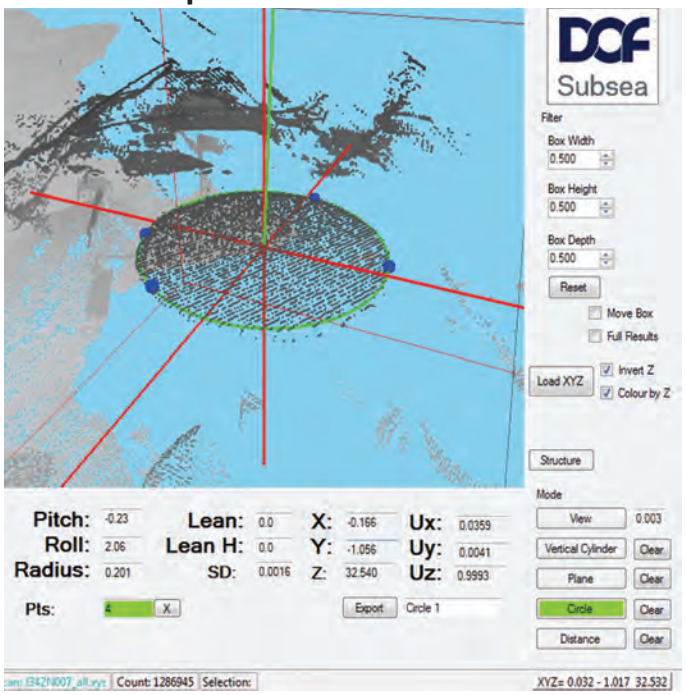
Laser metrology was undertaken and

Scansoft Laser Data image



All images courtesy DOF Subsea UK

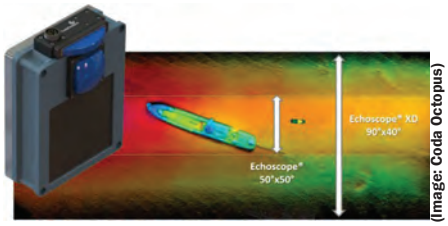
Metro direct picture



All images courtesy DOF Subsea UK

processed in a short time frame with results available onboard the vessel, without the requirement to transmit data to shore; additionally results from the AAINS laser metrology are proven to be within dictated specification for subsea metrology calculations. When asked about the demonstration, Pieter Jansen, Geomatics Global, said, "The combined system components brought together and showcased in Fort William were proof of further advancements within the survey industry, combining technological advancements with operational efficiencies. A much welcome and needed approach in an economically hard hit oil and gas industry."

Speaking about the success of the demonstrations, Colin Cameron, DOF Subsea said, "At DOF Subsea, we pride ourselves on working in partnership with industry leaders to develop new technological solutions to subsea challenges. The development of this solution is hugely important for the energy sector, and we were delighted with the data that we were able to gather in Fort William. We have proven that the technologies work together in this application and that the method can generate the quality and complexity of data required. We believe that using this combination of technology to provide a full metrology solution is an industry first - we can save days on traditional metrology work, and provide much higher quality data. This in turn brings savings to the operations teams running the projects."



(Image: Coda Octopus)

Coda Octopus

Addition to Range of Real-Time 3D

Coda Octopus has added to its range of real-time 3D sonar systems with a new wide-angle 90° x 40° 240kHz option to its Echoscope sonar.

The new variant has multiple projectors and affords increased opening angle, thus increasing the field-of-view and survey area of coverage, according to the manufacturer. In addition to the real-time 3D imaging, which enables the Echoscope to deliver efficiencies in projects where there is low or zero visibility conditions, the new XD Dual Frequency model will enable large area imaging and mapping to be efficiently and effectively completed in support of a wide range of subsea bathymetry and imaging projects.

www.codaoctopus.com

Teledyne RESON

Four News Multibeam Systems

Teledyne RESON has introduced four new multibeam sonar systems built on the SeaBat T-series platform: the Integrated Dual Head SeaBat T20-R & T50-R and the modular SeaBat T20-R & T50-R Multibeam Sonars. According to the manufacturer, these new multibeam sonars delivers improved data quality, enhanced sonar capabilities and a selection of sonar processors including the new Rack Mount processor.

www.teledyne-reson.com

Geosoft

UXO Marine Software

Geosoft's UXO Marine software for marine geophysical surveying provides processing and analysis of data to map and characterize unexploded ordnance (UXO), cables and pipelines and other hazards. New features include improved modeling of magnetic moment and other parameters; improved support for multiple magnetic sensors, especially gradiometers; and interactive accurate target-picking.

www.geosoft.com

Blueprint Subsea

Oculus M-Series of Multibeam Imaging Sonars


(Image: Blueprint Subsea)

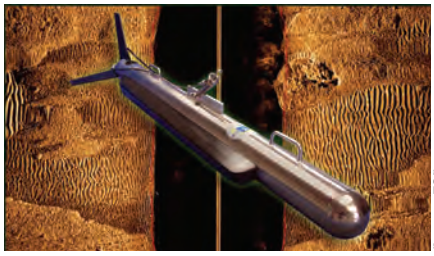
Blueprint Subsea's Oculus M series multibeam sonars are a new generation of imaging sonar, designed for use across a wide variety of underwater applications.

Their small form factor, weighing less than 400g in water, and dual frequency capabilities make them suited for deployment on micro sized platforms, while their rugged construction also makes them an excellent choice for larger work-class vehicles and subsea infrastructure.

The series includes three models:

- **Oculus M370s:** With a 200m range capability, this sonar is a cost effective alternative, typically being used for long range navigation and situational awareness.
- **Oculus M750d:** A general purpose dual-frequency sonar offering 120 meter range capability at 750kHz and 40 meter range at 1.2MHz.
- **Oculus M1200d:** Offering the highest resolution in the M series range, the M1200 may be used for specialized inspection tasks where image quality is critical.

www.blueprintsubsea.com


(Image: FSI)

Falmouth Scientific

HMS-624 Launched

Falmouth Scientific, Inc. (FSI) launched its new HMS-624 digital CHIRP Side Scan Sonar System, offering dual simultaneous 100/400 KHz frequency operation. The new HMS-624 leverages advanced technologies to provide superior imaging capabilities for deep and shallow water applications, the manufacturer said. The Tow Fish electronics incorporate FSI's CHIRPceiver 24-bit CHIRP signal processing, which results in high resolution side scan data at towing depths up to 2,000 meters.

The Topside Power/Data Multiplexer Interface is packaged in a standard 2U 19" rack mount enclosure and provides a 4Mb/s DSL connection for the Tow Fish and a standard Ethernet connection for the data processing computer.

www.falmouth.com

Teledyne Gavia/Klein

AUV Gets a Klein Sonar Upgrade

Teledyne Gavia has enhanced its modular, versatile, low-logistics subsea survey solution, the Gavia autonomous underwater vehicle (AUV), with the addition of an optional new Side Scan/Bathymetry module.

Incorporating Klein Marine Systems' new UUV-3500 high-resolution side


(Image: Teledyne Gavia)

scan sonar with optional bathymetry sonar, the system is another option for customers interested in utilizing the AUV for geophysical survey, cable and pipeline survey, environmental survey and under ice survey, as well as Mine Countermeasures (MCM), Rapid Environmental Assessment (REA) and Intelligence, Surveillance and Reconnaissance (ISR) surveys.

Equipping the Gavia AUV with the survey-grade long range side scan from Klein Marine Systems creates a mobile survey platform with high quality side scan range and resolution. The swath bathymetry option allows for wide swath performance which is typically 10 to 12 times the overall altitude of the AUV. The new module allows customers to have both side scan and swath bathymetry from a single module. The first delivery of the Klein UUV 3500 Module will occur in Q1 of 2017 and is integrated with the SeeByte Autotracker software for autonomous pipeline tracking. The Gavia AUV can also be equipped with a camera and strobe system for close inspection of any targets identified by the sonar system.

www.teledyne.com

Furuno

Multi-Beam Sonar hits new Depths

Furuno has brought side-scanning capabilities to its NavNet TZtouch and TZtouch2 MFDs with its latest network sensor called the DFF3D, a multi-beam Sonar that takes the capability to scan port to starboard under the vessel and adds Furuno's commercial fisheries spin on it. The Sonar delivers a sidebar detection range of 650+ feet, while being able to see down to over 1,000 feet.

The DFF3D utilizes a new, compact multi-beam transducer, along with Furuno's own signal processing, to produce images that will help find and track fish in 3D and real time. The transducer features a built-in motion sensor, which keeps the images stable, even in rough seas. The DFF3D features four display modes: Cross Section, 3D Sounder History, Triple/Single Beam Sounder and Side Scan.

www.furuno.com

(Image: Furuno)

Seafloor Systems

Debuts EchoBoat-G2

Seafloor Systems, Inc. has designed the EchoBoat-G2 unmanned survey vessel (USV) to execute survey missions via remote control or semiautonomously, utilizing modified Mission Planner Drone software. With Seafloor's AutoNav auto pilot module, the operator can preplan survey waypoints, upload via RF to the vehicle, and the EchoBoat drone will automatically execute the mission.

Users can inspect, secure and maintain harbors with the EchoBoat-G2 USV integrated with a Sidescan Sonar, Multibeam sonar system or real-time 2D/3D imaging sonar.

(Image: Seafloor Systems)

With the EchoBoat-G2 it is now possible for harbor patrol and port police to run regular surveys, impromptu post-storm/event debris mapping or routine inspection survey missions, for example—all via remote control and Laptop on the dock.

The lightweight, portable, multi-payload vehicle is made from noncorrosive materials and includes efficient dual-DC thrusters and an internal plug-and-play survey deck to seamlessly install a variety of sonar and navigational monitoring equipment.

www.seafloorsystems.com


MTR
100

THE TOP 100 SUBSEA COMPANIES

Every year *Marine Technology Reporter* selects the top 100 companies that have made significant contributions to the underwater technology community. Apply today and tell us why your company should be featured in July's *Marine Technology Reporter.*

APPLY TODAY:

http://mtr100.marinetechnologynews.com

Deadline for Entries: July 7, 2017

MARINE TECHNOLOGY REPORTER

THE NEW SITE FOR NEWS

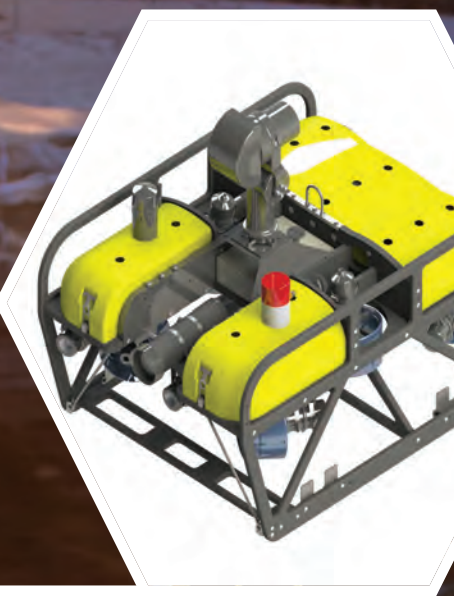
MarineTechnologyNews.com

The NEW online home of: MARINE TECHNOLOGY REPORTER

© kanonsky / Adobe Stock

Southern California Subsea Cluster

California Dreamin'



Photos: Scripps Institution of Oceanography

Leinen

Scripps Institution of Oceanography – one of the premiere institutions of ocean research and higher learning on the planet – is the hinge of the Southern California blue economy. MTR *recently spent some time with Margaret Leinen, Vice Chancellor, Marine Sciences, UC San Diego, Director, Scripps Institution of Oceanography, for her insights on the path forward.*

By Greg Trauthwein

I'm sure we can find Scripps' 'vital stats' online, but can you give a brief overview of the Institution that you run?

Scripps Institution of Oceanography at UC San Diego is a thriving center for ocean, earth and atmospheric science with more than 2,000 students, staff, researchers and volunteers. In the 113 years we've been in existence, our education and research mission has grown with leading experts in diverse fields across a broad spectrum of science with demonstrable value to the public. Dozens of Scripps projects throughout the United States and worldwide are problem-solving collaborations between our scientists and natural resource managers, urban planners, public health officials, the military, policymakers, philanthropists and citizen scientists.

It's thrilling to lead a truly stellar institution that features some of the greatest minds in our business. In fact, Scripps and UC San Diego were recently ranked by *Nature* magazine as the top earth and environmental research institution in the country, and fourth in the world. Scripps also proudly operates a research fleet with ships that have completed hundreds of missions in the past few years and our public Birch Aquarium at Scripps that welcomed nearly a half million visitors last year. I have to mention that Oceanology International has just recognized Scripps icon Walter Munk, the world-renown oceanographer and geophysicist, with a special (Catch the Wave) conference and we will be continuing that momentum with events and symposia in the months ahead as we celebrate his 100th birthday in October.

In your mind, how is Scripps unique from similar institutions around the world?

There are several first-rate ocean and earth science institutions making significant contributions around the world. I see Scripps Institution of Oceanography increasingly emerging as an institution that not only does the highest level of basic research on the ocean, atmosphere and earth, but also provides society with science-backed solutions to some of the world's most urgent challenges. Science at Scripps informs urban-, state-, national- and international level policy and planning.

As one example, in last year's El Niño season Scripps performed ultra high-resolution coastal elevation surveys that are helping the U.S. Navy understand risks to coastal infrastructure and the possible relocation of facilities affected by sea-level rise. Californians see the impacts of environmental change every day. Many at Scripps are involved in research to better understand the ocean and the atmosphere with projects to improve our ability to forecast change, describe impacts to regions, and aid in developing adaptation plans.

Scripps research recently helped municipalities around San Diego in understanding how to make beach nourishment efforts more cost-effective. Our scientists found that using the appropriate type of sand can help cities save millions of dollars in such efforts. This research is of great value given the impact to beaches from expected sea-level rise over the next century. We're also ramping up a new Center for Climate Change Impacts and Adaptation to help societies adapt and prepare for the significant changes ahead for our coastal communities.

What advantages do you have by being located in San Diego?

Scripps research spans the globe, from pole to pole and from Earth's interior to space. Our physical home base in San Diego, however, gives us several key advantages. For example, San Diego's Maritime Industry Report found that our local economy supports $14 billion of direct sales, 46,000 employees, and 1,400 companies focused on technical or non-technical marine related products and services. This provides Scripps with tremendous potential to partner with industry in innovation, research and workforce development. Being part of UC San Diego and the University of California, which focus so heavily on innovation and partnerships with industry, also carries tremendous advantages. University of California researchers and entrepreneurs have spawned hundreds of new companies employing tens of thousands. These businesses have contributed more than $20 billion to the state's economy. UC San Diego leads the UC system in startups. In fact, UC San Diego faculty, students and alumni have launched or created technology for more than 650 companies. Scripps is taking advantage of this leadership in innovation and commercialization by forging new collaborations with business partners.

What is Scripps' role in supporting, fostering the growth & benefitting from this Blue Tech cluster?

The Blue Tech economy is thriving, and Scripps is doing its part to help accelerate its growth. Last year, Scripps scientists and ship operations successfully competed for more than $130 million from federal agencies to support a range of research, monitoring, infrastructure, education and training programs, which feeds into the Blue Tech economy. With a deep history of collaboration with the U.S. Navy that goes back decades, Scripps provides "environmental intelligence" that's needed to give America an edge in terms of national security. Scripps also supports the cluster as an institution for research and education. Our faculty and staff are the experts who can provide expertise to policy makers and industry. We are training the next generation of scientific experts in earth, ocean and atmospheric studies who will go on to become leaders in academia, industry, government and non-profit work.

The Scripps Nimitz Marine Facility in San Diego's Point Loma community is the home base for our oceangoing research vessels and a major contributor to the maritime community. It's a bustling hub of seagoing activity. Last year we welcomed home research vessel Sally Ride, the newest ship in the U.S. academic fleet. All of this activity and participation in the Blue Tech cluster provides a forum for collaboration with industry for our mutual benefit.

Put in perspective how the public knowledge and perception of "the ocean" has changed over the years?

Not long ago societies considered the ocean an endless resource for human cultivation. Today, of course, we see human impacts have cut across the ocean, from overfishing to pollution to increasing levels of acidity. Exploration and observation are needed to track and understand these changes.
At Scripps we also see the ocean as a robust source for new marine-based medicines. Scripps is uniquely poised to translate marine-derived small molecules—from identification and characterization by our Center for Marine Biotechnology and Biomedicine with UC San Diego's Skaggs School of Pharmacy and Pharmaceutical Sciences—into collaborations that allow for pre-clinical and clinical testing.

We also have evolved to address the many unique and challenging aspects of understanding and protecting our planet. It will take more than one perspective to tackle some of our world's most pressing challenges and as part of UC San Diego, Scripps has unique opportunities for interdisciplinary research. Pushing the boundaries of innovative research increasingly requires collaboration. With that goal in mind we recently hired several new faculty members that will launch cutting-edge research at UC San Diego that addresses key perspectives on the impact of climate change on human health, policy, resilience, adaptation and other areas.

Photos: Scripps Institution of Oceanography

Photo: The office of Supervisor Greg Cox

Supervisor Greg Cox (right) at the grand opening of the **Tuna Harbor Dockside Market** in San Diego in August 2014. It is a great success story in the local Blue Economy.

Cox

By Greg Trauthwein

While San Diego is a historical maritime hub, with enviable weather and direct deepwater access to the Pacific Ocean, the growth of its "Blue Economy" needed a single, seemingly simple push. A name.

"I think a big part (of the growth and evolution in the Blue Tech Economy) is that it has a name now," said Supervisor Greg Cox. "Five years ago if you would have asked me what I think about the blue tech economy, I might not have known what you were talking about. Having a name that ties in all of the companies and employment opportunities, having a name gives us a handle on the 'blue economy.'" And with the name comes size and shape. Nearly five years ago the San Diego Regional Economic Development Council conducted a study to define the Blue Economy, and there it found:

- 46,000 jobs
- 1,400 companies
- A $14 billion impact on the local economy

"That study is now five years old, and it is my understanding they are working on an update; it's my feeling that the numbers will be larger across the board," said Cox.

Tuna Harbor

The San Diego Blue Economy is as diverse as you will find anywhere in the world. The U.S. Navy has a large and growing presence, it houses a burgeoning base of commercial entities including ship and boat building and repair, and it is home to Scripps Institute of Oceanography, one of the most prestigious institutes for study and research in the world. But the fishing industry, with a strong heritage of Portuguese, Spanish, Mexicans and Chinese, is its soul. To that end, Cox took particular interest when local fishermen at Tuna Harbor were having problems selling their fish to the public when they couldn't get proper permitting from the Department of Environmental Health, primarily because the port district didn't have a classification for leasing space for these fishermen.

"This was a lack of coordination between the country and the port district. When I (heard about it) I thought, 'this is ridiculous,'" said Cox. "We got our country officials together with the port district, and literally within two weeks we were able to give them a temporary permit to open what is now a mainstay down at Tuna Harbor every Saturday morning until the early afternoon, where you will have upwards of 1,000 people coming down weekly to buy some of the freshest fish you're going to find anywhere."

The permitting was temporary for more than a year until Toni Atkins, who at the time the speaker of the assembly but is now a state senator, drafted legislation which she called 'Pacific to Plate.' It changed state law so anywhere in California fishermen can sell their catch direct to the public. "It has been great success at Tuna Harbor, and that's just one of the success stories," said Cox.

Growing the Blue Economy

Cox said the Blue Economy isn't relegated simply to those that is directly the water. "In San Diego County we have many 'blue economy' businesses that are inland," said Cox. "These are jobs – blue collar and white collar jobs – that includes a wide range of sectors, from fishing to shipbuilding to underwater robotics and telecommunications. It's a wide swath of career opportunities." While Cox has the responsibility to facilitate growth in his region, he realizes that the business is global, and ultimately the industry in his region can grow stronger with collaboration and cooperation. For companies looking to export beyond the Southern California borders, or enter into cooperation with businesses and organizations in his area, he offers a simple piece of advice and conduit.

"I have become a strong advocate and supporter of The Maritime Alliance," said Cox. "The Maritime Alliance has done an outstanding job in promoting blue tech and blue jobs, by focusing not only on businesses, but also on education, and policy as well as technological resources. By its very nature the blue economy is international," and The Maritime Alliance does a great job in helping to bring them all together.

Energy Sales:
First Deep Ocean Alkaline

Image: Energy Sales

Underwater devices that need portable power, like those used for data logging or to measure conductivity, temperature and depth, face significant challenges. Operating beneath the sea means tidal forces, frigid temperatures and the corrosive nature of the very environment they are immersed in. However, the most daunting of these is the unrelenting effects of seawater pressure. To keep the effects of constant seawater pressure from imploding power cells, battery packs have been placed inside of pressure housings. While PVC housings are used down to 600-ft., other materials such as steel, iron, or for the deepest applications, titanium or advanced composites, can add significant cost to portable power consumables.

Energy Sales last month unveiled a new approach to pressure tolerance in the field of battery design. Developed for the deep ocean, the PTBS, a pressure tolerant battery system, addresses cost-efficient battery applications that work from 1800 to 3000 m. The design, initially featuring alkaline cells, replaces the need for housings made of costly materials.

"We worked with the University of Washington to identify and design in better cost efficiencies," said Jean-Michel Bourdon, CEO for the value-added battery specialist firm. "We've demonstrated a remarkable cost/performance breakthrough with the PTBS and it played out in all of our testing with UW." Because the PTBS uses alkaline cells, he pointed out, the new systems do not require UN transportation testing or certification. "Just one illustration of cost savings."

Specifications

Product Category: Battery Pack
Manufacturer: Energy Sales
RoHS: Not Applicable
Scalable Output Voltages: 3V to 63V
Scalable Capacity: 357 Ah to 17 Ah
Chemistry: Alkaline
Termination Style: Custom
Brand: Energy Sales
Packaging: Individual
Non-Rechargeable
Max. Operable Depth: 3,000m
Min. Temperature: 35.6°F

The PTBS is designed for untethered applications with long deployments such as data loggers, Sonde devices and bottom pressure recorders like those used on DART II Tsunami detection and warning systems. It operates as deep as 3000m and in temperatures as low as two degrees Celsius. It features a scalable design from 14 to 42 cells resulting in energy output flexibility from 360 to 900 Watt-hours (Wh). In addition, by using alkaline cells, the new system requires no United Nations (UN) transportation testing or certification.

"This pack designed by Energy Sales will reduce our costs for short term applications," said Chris Siani, Sr. Electrical Engineer at APL/UW. "Load and pressure tests done at my lab show that this battery pack design operates well at pressures up to 4,400 psi (~3,000m), without the need for costly steel or titanium housings. We are looking forward to using this new battery pack in upcoming projects."

www.energy-sales.com

Deep Ocean Engineering Debuts Phantom L6 ROV

San Jose, Calif. based Deep Ocean Engineering, Inc. has introduced its newest addition to the Phantom series of inspection-class remotely operated vehicles (ROV), the Phantom L6. "The PhantomL6 is our latest entry into the 500m inspection class ROV arena. It comes equipped with active roll stabilization and heading gyro stabilization, allowing the pilot to control with precision, while minimizing exhausting, repetitive movement. As with other Phantom series ROVs, we offer an open-frame architecture for easier mechanical integration, and dedicated expansion bulkhead connectors are provided as standard," said John Bergman, Deep Ocean Engineering, Vice President of Engineering. "Its six enhanced Tecnadyne thrusters provide sufficient power to raise the ROV out of areas that could otherwise trap a smaller ROV."

Standard PhantomL6

Active roll stabilization.
Advanced dynamic rolling maneuvers.
110 pounds vertical lifting force.
Motion eliminating cleats available.
Extreme payload capacity.
Diverse sonar integration options.
Five DOF maneuverability.
Easily reconfigurable and customizable.
18,000 lumens high output illumination.

Image: Deep Ocean Engineering

www.deepocean.com

Image: Birns

Oxnard, Calif. based BIRNS, Inc. opened in 1954, and has been serving the global marine industry ever since with high performance lighting and connector products.The technological advancements in the field of cable assembly development have been rapid and exciting in the last decade in particular. BIRNS has been creating new connectivity solutions that provide immense performance characteristics in relatively small packages. In its flagship connector line, the BIRNS Millennium series, BIRNS customers are able to rely on a 6km open face rated assemblies that combine high and low voltage electrical contacts, fiber optics and coax all in one connector. These compact connectors offer exceptionally high density pin configurations, even in highly complex combinations of contacts in close proximity to one another. To add more flexibility and performance in RF connectivity, BIRNS recently introduced a breakthrough technology in coax contacts, which provide open faced pressure resistance, a maximum insertion loss of 0.7 dB at signal frequencies to 3GHz, with an associated maximum SWR of 1.7:1. The new design also provides incredible ease of assembly and connects directly to a standard MIL-STD-348 SMA connector. For the requisite advanced termination and testing of these state-of-the-art, high density hybrid connectors, BIRNS' production and inspection technicians are J-STD-001 Class 3 and WHMA-A-620-A Class 3 certified. For example, extreme care must be taken to install, solder or polish each contact without interfering with surrounding ones during the intricate task of terminating a connector with a face of only approximately 2 inches diameter, but with several 50Ω RF contacts, multiple delicate optical fibers and more than 60 electrical contacts the work becomes even more challenging. WHMA-A-620-A and similar standards do not always address the types of cutting-edge assemblies which BIRNS produces, so for these types of complex hybrid pin configurations, BIRNS has developed new termination methodologies, including electro-opto-coaxial Progressive Sequencing. Without the use of such innovative termination methods, there would be a high risk of melting the insulation or breaking the fibers.

When it comes to testing, BIRNS has been exploring new, elegant methods to ensure that these minute but powerful assemblies are ready to perform as expected in some of the most demanding environments on the planet. Testing methodologies and equipment BIRNS has been utilizing include RF testing using an ENA Series Network Analyzer, which can test coax contacts from 100kHz to 18GHz.

www.birns.com

LinkQuest

The new FlowQuest 600 Micro acoustic current profiler operates at 600 KHz. It is similar to the standard FlowQuest 600 acoustic current profiler in terms of functions and performance, but is much smaller and lighter. The FlowQuest 600 Micro current profiler is 13 cm in diameter and 21.0 cm in length, and weighs less than 1.6 kgs in water. It will mainly be used for inland discharge measurements but will also be useful for oceanographic applications when smaller size and lighter weight are beneficial.

LinkQuest manufactures high-speed, power-efficient and robust 38,400 baud underwater acoustic modems and robust, accurate and cost-effective TrackLink USBL acoustic tracking systems utilizing advanced Broadband Acoustic Spread Spectrum (BASS) technology. LinkQuest's FlowQuest acoustic current profilers, FlowScout acoustic flow meters and NavQuest Doppler velocity logs provide highly competitive solutions for current profiling, discharge measurement, wave measurement or precision underwater navigation applications. LinkQuest also manufactures EchoSweep 300 Multibeam Echosounder, PinPoint LBL acoustic positioning systems and Precision Marine geodetic systems used for tsunami and earthquake monitoring and prediction.

www.link-quest.com

Image: LinkQuest

Blue Robotics

Image: Blue Robotics

Blue Robotics, based in Torrance, Calif., makes the BlueROV2, the world's most affordable high-performance remotely operated vehicle (ROV). With a six-thruster vectored configuration, open-source electronics and software and plenty of expandability, it's the perfect ROV for inspections, research and adventuring. Production began in Torrance in July 2016, and there are now more than 200 vehicles in the wild to date. A high quality and low cost design paired with a highly configurable and customizable design, the BlueROV2 is suitable for a plethora of jobs. The BlueROV2 utilizes the open source ArduSub software, based on the renowned unmanned aerial vehicle (AUV) platform, ArduPilot. The software is actively developed and improved by Blue Robotics and other contributors, with constant upgrades and improvements to make the BlueROV2 even better. Support for new features and accessories is currently in development.

Since its launch last summer, kits have been undergoing frequent improvements allowing for an even smoother build process. In its current state, the kit requires no soldering, potting, or gluing and can be assembled in about eight hours.

Blue Robotics has recently released a lithium-ion battery (14.8V, 18Ah), which is now shipping to countries in North America, Singapore, India, Japan, New Zealand, Australia, and will soon be available to most of Europe. The high capacity custom battery pack is made from high quality 18650 lithium-ion cells designed to fit perfectly inside the BlueROV2's watertight battery enclosure. This battery allows up to four hours of continuous moderate use on the BlueROV2 and can be swapped in seconds.

On the market for just over eight months, the BlueROV2 has already proven itself through hundreds of hours of successful missions in the field. By partnering with local California businesses and organizations, Blue Robotics has been able to introduce the BlueROV2 to a number of environments and applications, adding to its ever growing repertoire of capabilities. An inspection of a San Fernando Valley water reservoir, an investigation of plane wrecks in the Salton Sea, and a survey of the hull of the Battleship USS Iowa name just a few of the many missions performed recently with the BlueROV2.

The BlueROV2 has been and will continue to be critical in advancing ocean accessibility for the masses.

www.bluerobotics.com

SIDUS Solutions

Sidus Seafloor Observer Camera System

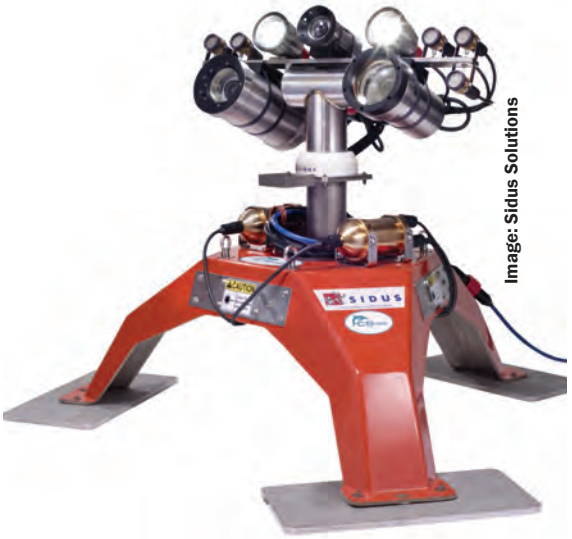


Image: Sidus Solutions

San Diego-based SIDUS Solutions is a manufacturer and an integrated systems provider of robust video surveillance systems. SIDUS provides services and equipment for subsea, heavy commercial, industrial and oil and gas markets. SIDUS' primary products are image transmission, storage and retrieval systems. These products allow for the capture, inspection, observation, storage and evaluation of the customers' applications. The urgency and requirement for target customers to acquire high quality, intelligible images and to integrate these images within their operations is the basis for the company's business.

SIDUS' solutions are fully capable of operating in any industry requiring remote surveillance systems.

Its offerings are not limited to technology solutions; SIDUS' customers also have the opportunity to take advantage of complete start to finish solutions including project management, custom manufacturing, system integration, project engineering, installation Support, research and development, commissioning service and customer support.

www.sidus-solutions.com

Global Ocean Design

Image: Global Ocean Design

Patented technology and innovative design are found in Global Ocean Design's line of benthic landers, range-and-bearing-to-target locating beacons, moisture removing vacuum purge systems, pressure-activated switches, polystyrene instrument spheres, burnwire release devices and more.

The Nanolander, is a self-contained exploratory vehicle utilizing 10" buoyancy spheres for long duration benthic and mid-water exploration and monitoring using third party sensors packages, from such manufacturers as SeaBird and RBR. Two versions are available, rated for 1km or 10km depths. These are widely deployable from ships of opportunity without need for winch, wire, crane or A-frame. A simple wooden ramp, tipped up is all that is required. Anchors are sourced in the port of operation. Larger landers using larger 13" and 17" glass spheres are also available. Numerous anchor release options include acoustic release, countdown timer release, bottom contact release and Galvanic Time Release.

The company's Beacon Board is a new idea in surface location devices. Using a pair of GPS receivers linked by a VHF radio, a surface recovery ship receives a direct range-and-bearing to a surface target, such as a lander returned to the surface. The bearing, in the form of a large red arrow pointing the way, and a numeric distance display, is an unambiguous means to determine the location of your target within a line-of-sight radius of up to 8 nautical miles of the ship. This recovery aid fits easily inside a glass or polystyrene spheres as small as 10" OD. It operates despite night, rain, fog, sun glint or other boats.

The G141 10" OD polystyrene spheres work to 1,000m, making a low-cost pressure case alternative that provides both a housing and buoyancy. They come standard with an o-ring face seal, four 7/16-20 tapped connector ports with blanking plugs, and a vacuum port. With only 5psi vacuum differential (approximately 10psi internal), the spheres are held together with nearly 300-lbs of force.

www.globaloceandesign.com

Planck

Planck Aerosystems builds unmanned aerial systems (UAS) for maritime professionals. Based in San Diego, Planck was founded on the idea that putting an aircraft on every boat would represent a transformational change to maritime industry through improved data acquisition, situational awareness and safety. Planck has built the technology to make the dream of putting a drone on every boat a reality. Founder Josh Wells and lead engineer Allan Matthew conducted a series of technology demonstrations during Oceanology International North America (OINA), held in San Diego February 14-16, 2017. During these demos, selected OINA attendees got a chance to see Planck's technology in action in South San Diego Bay.

Planck's guidance, navigation and control system enables fully autonomous flight of a drone, to and from a small boat, at sea, all while underway. Demo attendees were chosen from across the hydrographic, oceanographic research and government sectors, and spent an hour on Planck's test boat. Having never previously flown a drone, attendees were given a tablet, and were able to plan a mission, launch the aircraft and land the aircraft on the boat, all while underway. The aircraft does all controls onboard, and compensates for boat pitch, roll, heave and forward motion – to guide takeoff and landing with centimeter-level accuracy.

www.planckaero.com

Image: Planck Aerosystems

Chesapeake Technology

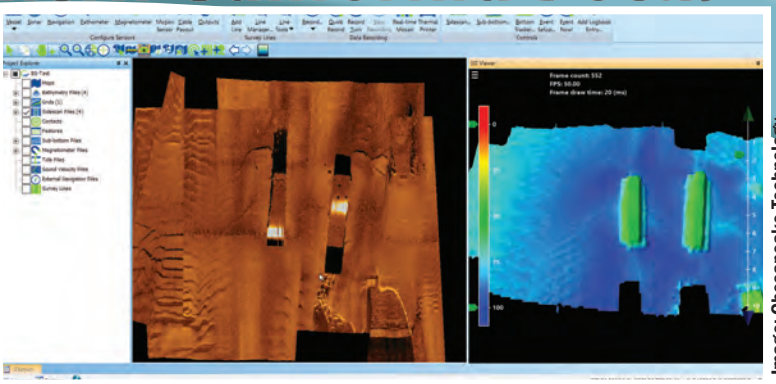


Image: Chesapeake Technology

From its launch as one of the first suppliers of PC-based sonar sidescan processing tools 20 years ago, Chesapeake Technology has grown to become a leading supplier of sea floor mapping software. This year, in a major initiative designed to help marine professionals leverage new sonar systems' most complex features, Chesapeake Technology will introduce the SonarWiz 7 advanced marine mapping solution.

SonarWiz 7, the culmination of more than a year of development effort, allows users to streamline workflows, helping them use time efficiently while producing high quality images.

"The new software helps ensure our interface will be consistent for users regardless of sonar system used," said John Gann, Chesapeake's VP of Engineering. "It will allow us to continue to support legacy sonar systems while maintaining compatibility with the industry's most advanced sonar technology. All within a software architecture that's more robust than ever." The upgrade to SonarWiz 7 is available at no charge to customers who have a current maintenance agreement.

Users will be able to visualize raw sidescan and sub-bottom data without the need to apply gains or set signal processing options. The new software will provide full support for swath bathymetry systems; for example, the updated SonarWiz contact manager and database will allow users to capture both bathymetry and acoustic image data for each identified contact. And the SonarWiz's advanced seabed classification tools will work seamlessly across all swath mapping systems such as Sidescan, interferometric and MBES. The tools will also feature more classification options, including a robust, multi-hierarchical manual classifier, textural analysis and GeoCoder.

"We've redesigned out entire architecture to minimize special cases and allow for more opportunities for software automation," Gann said. "The result is a more stable, consistent platform that is well suited to process the vast array of information produced by state-of-the-art sonar systems."

CTI will exhibit at Ocean Business 2017 this April in Southampton, U.K., providing SonarWiz 7 water demos, with sonar manufacturers, Geoacoustics and Edgetech, as well as a training class during the exhibition. For customers able to extend their stay, the SonarWiz development team will be hosting a one-day workshop at the University of Southampton on Friday, April 7. This training will cover post-processing for sidescan, sub-bottom, bathymetry, and magnetometer data, as well as tips and tricks utilizing the latest features.

www.chesapeaketech.com

DimEye

Image: DimEye

In February 2017 DimEye released the diver version of its 3D subsea inspection system: VLS (video laser scan). The system is based upon a combination of advanced photogrammetry and laser triangulation techniques: photogrammetry provides characteristic points and features of the object to be measured as well as precise location and orientation of the cameras, while laser triangulation allows the measurement of thousands of 3D points on every single laser line projected on the object surface.

This system covers two big fields of application: engineering projects and integrity management.

Engineering projects always require a detailed and reliable knowledge of the existing installation in order to prepare the modifications and/or the design of new components: the VLS survey will provide an accurate 3D as-built CAD model of the existing installation, thus minimizing risks significantly. This VLS configuration requires the use of an HD camera (no need for a laser line projection device).

Integrity management requires reliable information on potential "anomalies" and comparisons between periodical surveys in order to identify trends: the VLS survey will provide high accuracy local point clouds and meshes as well as all dimensions of "anomalies" and comparison to theoretical and previously measured shapes. This VLS configuration requires adding a laser line projection device to the HD camera in order to generate high-density point clouds on surfaces. By capturing about 30 images per second with laser line, the density of the point cloud can easily be selected during the post-processing step through the selection and extraction from the video of the corresponding number of images.

www.dimeye.com

Image: Forum

Forum ROV Simulator @ Cali Science Center

Forum Energy Technologies, Inc. has delivered a custom-built simulator to California Science Center, the largest hands-on science museum in the Western U.S. The dual simulator station provides visitors with the experience of operating a subsea remotely operated vehicle (ROV) for themselves.

The core technology used in the simulator is Forum's proprietary VMAX ROV Simulation Software used by Forum's ROV customers for training and evaluation of their ROV pilots. Forum's development team has tailored the control interface within the software to allow the virtual ROV to be flown by visitors with no prior experience. The control consoles provided use the same robust hardware as Forum's standard ROV control consoles. The system runs in both English and Spanish.

The exhibit features two simulation stations, each with a main joystick to control the ROV and a second smaller controller that operates the ROV's onboard manipulator.

VMAX developers worked with the Science Center team to develop two missions, one for each simulator console, each designed to provide the user with an experience of piloting an ROV and using onboard tools to perform a task. One scenario in the simulation sees users navigating their way around a series of hydrothermal vents billowing out clouds of volcanic fluid. The second involves collecting samples of sea life and identifying species.

Andy McAra, product director, Visualsoft and VMAX at Forum, said, "The VMAX team were very excited to be awarded this contract by the California Science Center. We are much more used to developing scenarios with manmade structures found in offshore oil and gas fields whereas this project involved interaction with natural obstacles and wildlife.

"One of the big challenges was striking a balance between making the system operable by inexperienced users whilst providing those users with a realistic experience. This is certainly one of the most enjoyable simulator installations that the VMAX team has delivered."

www.f-e-t.com

Tecnadyne

For more than 30 years Tecnadyne has been a leader in the worldwide subsea robotics industry, manufacturing underwater brushless DC propulsion systems, rotary and linear actuators, pan and tilt positioners, hydraulic power units, position sensors and pressure compensators for use on remotely operated vehicles (ROV), autonomous underwater vehicles (AUV), manned submersibles and other subsea platforms.

Many ROV manufacturers (including ECA Robotics, Deep Ocean Engineering, Outland Technology and Shark Marine, to name a few) use Tecnadyne thrusters on their vehicles. Tecnadyne products are presently being used on thousands of vehicles throughout the world, operated by many offshore oil service companies, universities and research institutions. Recent customers include Woods Hole Oceanographic Institute, Stanford University, University of Washington APL, Lockheed-Martin, Boeing, GE Nuclear, Oceaneering International, Mitsui Engineering & Shipbuilding, L-3 and Electric Boat.

Tecnadyne has recently focused its attention on the growing AUV market and the need for higher efficiency thrusters. AUV specific thrusters share many characteristics with Tecnadyne's other products – maximum performance and reliability in the harshest of environments. However, unlike an ROV or manned submersible, the optimal AUV thruster must be purpose analyzed, designed and manufactured to provide the highest achievable performance within a performance window that is unique to each different AUV.

www.tecnadyne.com

Image: Tecnadyne

MTR Marketplace

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

MTR Marketplace

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

Advertiser Index

Page	Company	Website	Phone#
19	APC International, Ltd.	www.americanpiezo.com	(570) 726-6961
78	AUVSI XPONENTIAL 2017	www.xponential.org	Please visit us online
25	COVE	www.coveocean.com	(902) 334-2683
5	Deep Ocean Engineering, Inc.	www.deepocean.com	(408) 436-1102
27	DeepWater Buoyancy, Inc.	www.deepwaterbuoyance.com	(207) 502-1400
C3	EvoLogics GmbH	www.evologics.de	49 30 4679 862 0
31	FarSounder, Inc.	www.farsounder.com/polar	(401) 784-6700
17	General Dynamics Mission Systems	www.bluefinrobotics.com	(617) 715-7000
15	Government of Newfoundland and Labrador	www.gov.nl.ca/BTCRD	Please visit us online
13	Greensea Systems, Inc.	www.greenseainc.com/brochure	(802) 434-6080
3	Hydroid, Inc.	www.hydroid.com/IAMREMUS	(508) 563-6565
47	JW Fishers Mfg Inc.	www.jwfishers.com	(508) 822-7330
27	Klein Marine Systems, Inc.	www.KleinMarineSystems.com	(603) 893-6131
29	Kongsberg Subsea	www.km.kongsberg.com/underwatermapping	Please visit us online
1	Kraken Sonar Systems, Inc.	www.krakensonar.com	Please visit us online
21	MacArtney A/S	www.macartney.com	Please visit us online
43	Ocean Sensor Systems, Inc.	www.oceansensorsystems.com	(954) 796-6583
53	Ocean Sonics Ltd.	www.OceanSonics.com	Please visit us online
55	OceanServer Technology, Inc.	www.ocean-server.com	(508) 678-0550
C4	RBR Limited	www.rbr-global.com	Please visit us online
7	Saab Seaeye Ltd.	www.seaeye.com	Please visit us online
41	SBG Systems	www.sbg-systems.com	Please visit us online
61	Seco Seals, Inc.	www.secoseals.com	(714) 546-3478
11	Shark Marine Technologies Inc.	www.sharkmarine.com	(905) 687-6672
39	Silicon Sensing Systems Limited	www.siliconsensing.com	+44 (0) 1752 723368
59	Soundnine, Inc.	www.soundnine.com	(866) 388-7277
53	SubCtech GmbH	www.subctech.com	+49 (0) 431-22039 884
23	Teledyne Caris, Inc.	www.teledynecaris.com	Please visit us online
9	Teledyne Marine	www.teledynemarine.com	Please visit us online
33	Valeport Limited	www.valeport.co.uk	44 (0) 1803869292
C2	VideoRay LLC	www.videoray.com	(610) 458-3000
51	Zago Manufacturing	www.ZaGO.com	(973) 643-6700

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

UNDERWATER COMMUNICATION AND POSITIONING SOLUTIONS

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions availableh

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, **new S2CM-HS high-speed modem**, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

Meet us at
OCEAN BUSINESS 2017!
4-6 April 2017
Southampton, UK
Stand W19

EvoLogics GmbH
Ackerstrasse 76,
13355 Berlin, Germany

tel.: +49 30 4679 862-0
fax: +49 30 4679 862-01

sales@evologics.de
evologics.de

A great addition to your cast.

The updated RBR*concerto* C.T.D|fast12, with streamlined CT cell for dynamic performances.

Up to 12Hz profiling, USB download, and twist-activated WiFi options.

RBR

rbr-global.com