MARINE TECHNOLOGY REPORTER

May 2011 www.seadiscovery.com

5-minutes with
Barbara Fogarty
Coordinator,
Ireland's National Marine
Technology Program

Technologies to Control & Command the
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Market Report
PiezoElectric Ceramics

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ABOVE: A film crew from the SyFy Television Series *Destination Truth* prepares a VideoRay Pro 4 HD ROV system for underwater filming. The ROV was used to search in Canada's Okanagan Lake for a fabled water dwelling serpent called the Ogopogo. The lake serpent remained elusive, however, the crew obtained beautiful underwater HD footage of the lake environment while safely operating from their small vessel.

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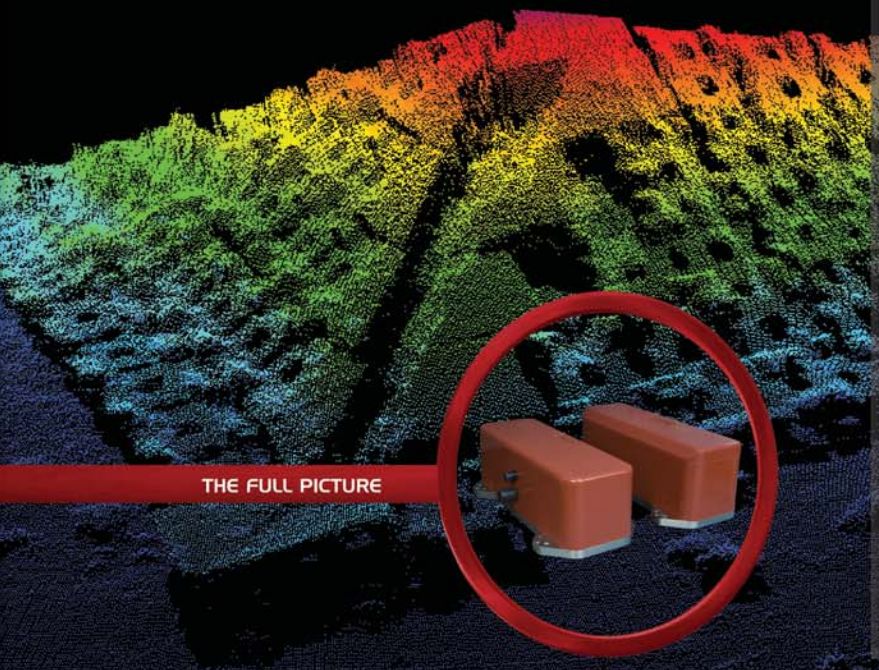

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May 2011

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Marine Technology Reporter • Volume 54 • Number 4

Pictured on the Cover

is Rockland Scientific's the **microRider-1000-6**, a small instrument package for turbulence microstructure measurements, designed to integrate with a variety of instrument carriers, such as Ocean Gliders, AUV, ROV, CTD rosettes, and profiling floats. microRider-1000-6 features include: Internal Data Recording; 1000 m pressure rating; Up to five turbulence sensors; 2x SPM-38-1 microstructure turbulence shear probes; 2x FP07-38-1 microstructure fast thermistors; and more. *(Photo Courtesy Rockland Scientific)*

Pictured in the background: A Hydroid REMUS AUV on the docks and ready for demo at the recent Ocean Business 2011 in Southamptong. *(Photo: Greg Trauthwein)*

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Andrew Safer is a St. John's, Newfoundland based subsea technology writer.
See Story on page 16

Karl Kenny is CEO, Marport Deep Sea Technologies Inc.
See Story on page 38

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See Story on page 44

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Last month in Southampton the industry gathered for Ocean Business, which is quickly becoming a signature event held every other year. Held at the National Oceanographic Center, it combines traditional exhibit with in-water demonstration and conferences. Many companies used the venue to introduce new products and systems, and a comprehensive "New Technology" reports starts on page 50.

Looking closer to home, this month New Wave Media, the owners of *Marine Technology Reporter*, offers the fourth **OceanTech Expo** (**www.oceantechexpo.com**) held under tents on the docks in Newport, Rhode Island. While OTE is substantially smaller than the large European shows, it has grown a steady and loyal following since its debut four years ago, and today stands as a true testing ground for innovation, as it combines traditional exhibits with a long list of in-water demonstrations, including: **Bluefin Robotics**' Bluefin-9 AUV; **Deep Ocean Engineering's** Vector T-4 ROV; **Imagenex**' Model 965 Multibeam Imaging Sonar; **Marine Sonic's** Seascan HDS Digital Sidescan Sonar; **OceanServer's** IVER-2 AUV; **Reson's** 7125 SV; **SAIC's** Integrated Survey System (ISS); **SeaBotix**' vLBV 300 ROV; **Sea Sciences**' Acrobat Model LTV-50X Tow Vehicle; **Sound Metrics**' ARIS Explorer 3000 Underwater Imaging Sonar; **Tritech's** SeaKing Hammerhead Survey Sonar & Gemini Multibeam; VideoRay's Pro 4 ROV; and GEG's Inspection Class ROV 'Predator'.

This year is shaping up to be the best OTE yet, with the aforementioned in-water demonstrations; packed exhibit tents; a full roster of compelling speakers and topics (see the full schedule on pages 48-49); and three days of social networking and events. In particular, we are honored that **CNO Admiral Gary Roughead** has accepted our invitation to attend the "Sunset Reception" on Tuesday, May 17, in his honor, to receive his "Seamaster of the Year" award from MTR. The CNO has signaled the ambition to significantly increase the U.S. Navy's use of unmanned underwater systems, and I'm certain his comments following the ceremony will be of interest to any and all serving the subsea industry. We look forward to seeing you there.

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Air France Wreckage Found

A search team led by the Woods Hole Oceanographic Institution (WHOI) located the wreckage of Air France Flight 447 some 3,900 meters, or nearly 2.5 miles, below the surface of the Atlantic Ocean off Brazil's northeastern coast. Three of Hydroid's REMUS 6000 AUVs aided in the search for and discovery of wreckage from the downed Air France flight, nearly two years after the plane was lost.

That success came just one week into the latest mission "attests to the efficiency of the vehicles and the competence of this team," said WHOI Senior Engineer Mike Purcell.

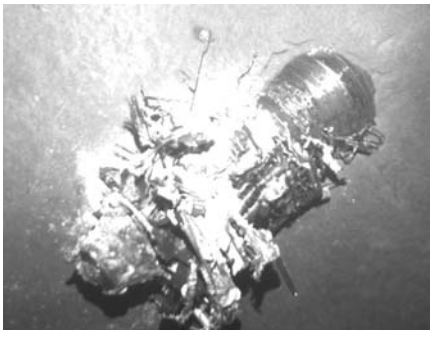
The Airbus A330-200, traveling from Rio de Janeiro to Paris, crashed on June 1, 2009, after encountering severe thunderstorms. It was carrying 216 passengers and 12 crew. The search team, led by WHOI – and under the direction of the BEA, Bureau d'Enquêtes et d'Analyses – employed two REMUS 6000 vehicles owned by the Waitt Institute for Discovery and another owned by Leibniz Institute of Marine Sciences (IFM-GEOMAR).

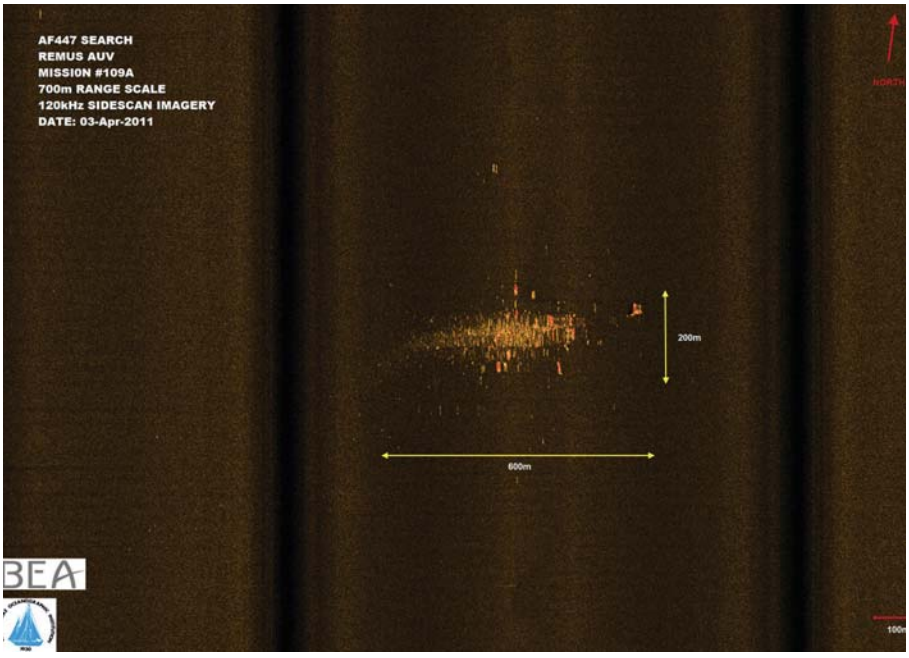
On April 3, 2011, through the use of the Hydroid REMUS 6000 vehicles equipped with EdgeTech dual frequency side scan sonar and 4 mega pixel digital cameras, searchers discovered and large pieces of debris, including parts of the aircraft's wings, engine, landing gear and fuselage. This was the fourth search mission since the 2009 crash.

The REMUS 6000 AUV is the deepest member of Hydroid's growing family of AUVs.

It was designed under a cooperative program involving the Naval Oceanographic Office (NAVOCEANO), the Office of Naval Research (ONR) and WHOI in support of deep-water autonomous operations.

The vehicle boasts the same proven software and electronic subsystems found in Hydroid's highly successful REMUS 100 AUV and is capable of carrying a payload to great depths in order to measure ocean water characteristics and map the seabed.





Images from the wreckage of Air France Flight 447 Below: Side scan sonar image of the site; Right, from the top: the engine; a wing; and landing gear.

(Images courtesy of the BEA)

Maersk Line Joins World Oceans Expedition

On April 5, 2011, the Virgin Oceanic Expedition Team confirmed Danish shipping company Maersk Line as the official shipping and research partner of the Virgin Oceanic 'Five Dives' expedition. The initiative is headed by Sir Richard Branson, founder of the Virgin Group, and the American explorer and sailor Chris Welsh. The five dives to the bottom of the world's oceans will be carried out by Sir Richard Branson and Chris Welsh who will each man an innovative new-built deep dive submarine, subject to receipt of all required regulatory approvals. The deepest dive will take the adventurer 36,000 feet down to the bottom of the Mariana Trench after which he will be able to 'fly' six miles across the Trench floor. The dives will run over a period of two years, after which the submarine will be donated to a U.S. museum.

Deep Challenger Dives

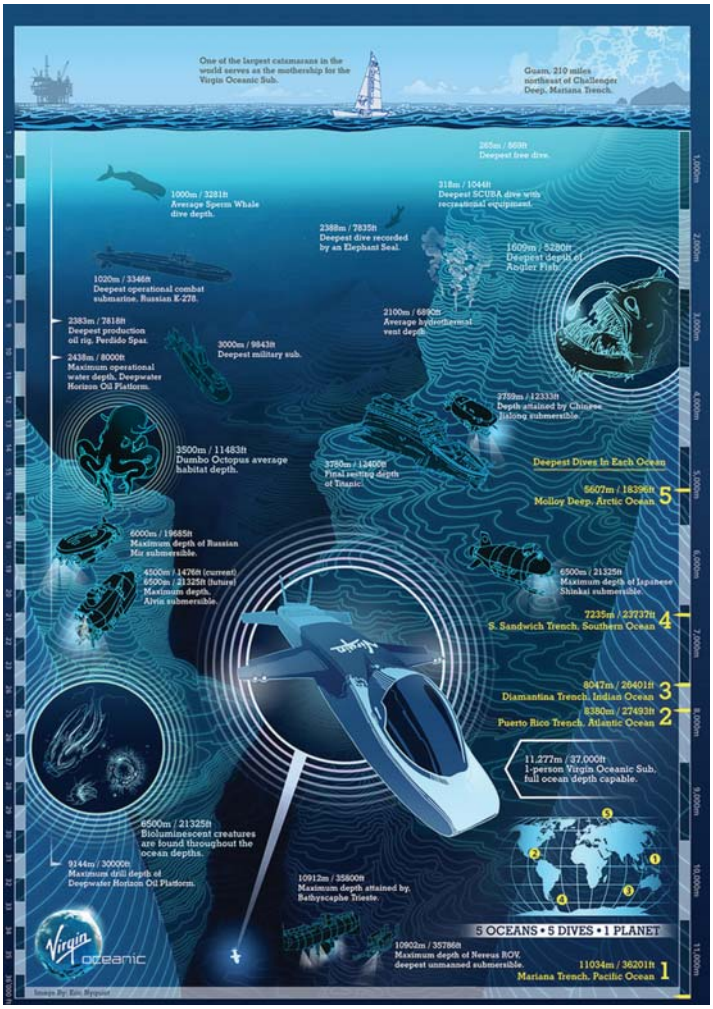
- **Dive 1** - Mariana Trench, Pacific Ocean
- **Dive 2** – Diamantina Trench, Indian Ocean
- **Dive 3** – Puerto Rico Trench, Atlantic Ocean
- **Dive 4** – Molloy Deep, Arctic Ocean
- **Dive 5** – South Sandwich Trench, Southern Ocean

"The Five Dives expedition is a unique and exciting opportunity for Maersk Line to support scientific ocean research. It is well aligned with our aspirations on improving the understanding of the state of the world's oceans" says Eskild Lund Sorensen, Head of Marine Stewardship, Maersk Line.

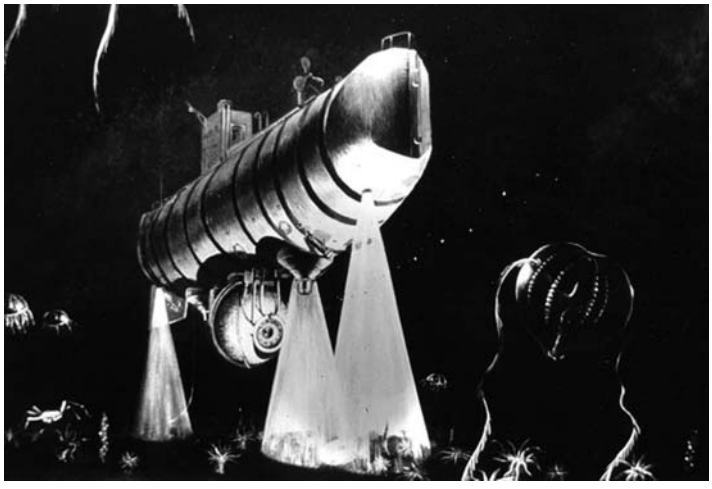
Maersk Line has contributed to the funding of the scientific equipment used in the expedition to collect and analyze samples from the submarine dives and catamaran voyages. Maersk Line's sponsorship may also include the transportation of the submarine and other equipment for the expedition, subject to receipt of all required regulatory approvals.

The expedition embarks from San Diego in the summer with the first dive taking place off the coast of Guam in the Mariana Trench. Over the course of approximately two years the team will uncover the deepest trenches of the Indian, Atlantic, Arctic and Southern Ocean.

www.virginoceanic.com

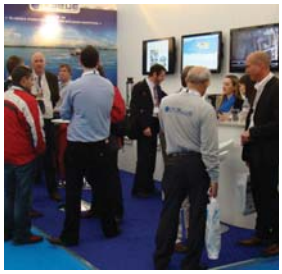


(Photo Courtesy Virgin Oceanic)



A late 1950s artwork, depicting Trieste operating on the deep ocean floor.

(U.S. NHHC Photograph. www.history.navy.mil/photos/sh-usn/usnsh-t/trste.htm Photo Courtesy Virgin Oceanic)



The *Marine Technology Reporter* booth (left) was busy for three days, as Rob Howard, VP Sales, found.

OB: A Successful Three Days in Southampton

Ocean Business 2011 closed on Thursday, April 7 in Southampton, UK, following a successful three days of conference, exhibition, in-water technology demonstration and full calendar of social events. The ensuing images help capture the essence of the festivities.

For details on new technology announced at OB, turn to page 50

John Head (right), Prevco, reported steady traffic in the new dockside tent.

Valeport enjoys a strong position in the show ... and in the market.

L to R: William (Bill) Green, Director of Marketing & Sales, and Konstantin Nakovski, Engineer at PMI Industries.

Bluefin to Develop Mine and IED Neutralization Variant of HAUV

Bluefin Robotics won a contract to develop a robotic ship hull mine and Improvised Explosive Device (IED) identification and neutralization capability for use in Joint Service Explosive Ordnance Disposal. A manipulator arm will be integrated onto the HAUV, a hovering AUV designed specifically for ship hull inspection. HAUN-N is the name of the new variant of the HAUV. The Bluefin Team — consisting of Bluefin Robotics, Oak Ridge National Laboratory of Oak Ridge, Tennessee and Orca Maritime of San Diego — proposes to accomplish the task with an HAUV-N equipped with a high-precision manipulator arm and a video camera.

www.bluefinrobotics.com

Republic of Korea Navy Adds Schilling Robotics' New HD System

Schilling Robotics received order for a new 150hp, 3,000m rated HD ROV system from GMB USA, Inc. for delivery to the Republic of Korea (ROK) Navy.

www.schilling.com

Pressure Hull For Submarine Mississippi Done in Record Time

General Dynamics Electric Boat reached a major construction milestone on the submarine Mississippi (SSN-782), completing work on the pressure hull in less time than any previous ship of its class. Electric Boat achieved "pressure hull complete" three weeks faster than the previous Virginia-class submarine record. Additionally, work on Mississippi's radar, hatches, sonar dome and piping systems is significantly ahead of the record schedule attained on USS Missouri, the most recent submarine delivered to the U.S. Navy by Electric Boat.

Subsea 7 Contract in North Sea

Subsea 7 won an engineering and installation contract by E.ON Ruhrgas UK E&P for the Huntington Development in the North Sea. The Subsea 7 workscope comprises the installation of 12km of the 8-inch Gas Export pipeline, installation of infield flexible flowlines, main static umbilical and associated risers as well as installation of subsea structures followed by tie-ins, pre-commissioning and system testing.

Blowing in the Wind

Offshore Wind Opportunities are advancing quickly

For too long, particularly in the U.S., the term "renewable energy" has played the role more of a marketing catchphrase than serious business endeavor. While the renewable energy market continues to face a number of technical and political hurdles – particularly in regards to efficient power transport and storage; as well as the "not in my backyard" mentality of the latter – renewable energy projects, particularly offshore wind projects, are slowly starting to pick up steam; a welcome potential stream of business for the subsea community, which provides crucial data and technical assist from site selection through unit installation and life-cycle maintenance.

Recently the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), in partnership with the state of New Jersey, announced that it will publish a Call for Information and Nominations (Call) to gauge interest in future wind energy development on the Outer Continental Shelf (OCS) offshore New Jersey in the *Federal Register*. Secretary of the Interior Ken Salazar recently identified this area of New Jersey as a Wind Energy Area (WEA), under the "Smart from the Start" initiative, for further study and consultation to foster responsible and efficient leasing and development.

Technology Drivers

There is a long list of new technologies in development to help install, service and decomission offshore wind farms, including:

• Knud E. Hansen A/S (KEH) is setting sail in the offshore wind energy sector. Recently, Swire Blue Ocean ordered a second deep-water turbine installation vessel, to be built by Samsung Heavy Industries in Korea to a KEH design. These six leg DP2 jack-up vessels soar 22m above the water surface in up to 75m water depth. The company also recently secured ongoing involvement in the Anholt Offshore Wind Farm project off the Danish coast with long term client MT Højgaard A/S. KEH involvement includes project management, operational & installation procedures and engineering support.

Furthermore KEH is at present securing patents for a least two designs within the offshore wind energy sector.

The first, related to safe and sustained access to offshore turbine foundations in rough weather. The second is a complete offshore maintenance vessel solution capable of servicing multiple installations simultaneously.

• Keppel FELS Limited (Keppel FELS) won a contract from the joint-venture Aarsleff Bilfinger Berger (ABJV) Dan Tysk, has been secured for SEAFOX 5, the KFELS Multi-Purpose Self-Elevating Platform (MPSEP) wind turbine installation vessel owned and managed with the Seafox Group. Keppel FELS is on track to complete the construction of SEAFOX 5 in the second half of 2012. When delivered, the vessel will be used for installing offshore wind foundations in the 288 megawatt (MW) DanTysk windfarm, developed by Europe's leading energy company Vattenfall and Stadtwerke München, in the German sector of the North Sea.

Wärtsilä and Aker Solutions jointly developed a High Performance Turbine Installation Vessel. This HPTIV can operate in year around weather conditions with an operational water depth range of 4.5-50m.

• Wärtsilä and Aker Solutions recently agreed to jointly develop a new concept for offshore wind farm installation vessels (pictured above). The new vessel concept will be marketed as a complete package. It will fulfil the industry's requirements for large deck space, sufficient crane capacity, year-round and all-weather operational capability and cost-efficient operating systems. It is designed for operating in the International Maritime Organization's emission control areas (ECAs).

• ABS released a Guide for Building and Classing Offshore Wind Turbine Installations, the first Guide to address design considerations for the bottom founded support structure of an offshore wind turbine situated in tropical storm prone areas on the U.S. Outer Continental Shelf (OCS) such as the Gulf of Mexico and East Coast. ABS' Guide is the first to specifically consider the conditions these structures may encounter in tropical storm prone waters.

Glider Research & Development

Dr. Ralf Bachmayer is the Canada Research Chair in Ocean Technology at Memorial University in St. John's, Newfoundland and Labrador. In June 2010 he opened the Autonomous Ocean Systems Laboratory (AOSL) in the Faculty of Engineering and Applied Science, and is currently supervising five master's degree students and three doctoral students in Ocean and Naval Architectural Engineering from Canada, China and Iran on various projects. The lab is equipped with an inspection-class ROV, an unmanned surface vehicle and two Slocum underwater gliders are on loan from the Canadian Centre for Ocean Gliders in Victoria, British Columbia.

by Andrew Safer

Can you tell us about one of the projects you have been working on with your students?

Bachmayer (Pointing to a glider in the lab) The Hybrid glider came out of a discussion on ice profiling I had with some colleagues when I was working on AUV control and operations at the National Research Council's Institute for Ocean Technology (located next door to the Faculty of Engineering Applied Science). With regard to operations under the ice, one of the things you want to know is how thick the ice is, and often you also want to be able to go for distances of hundreds of miles. The current state-of-the-art in AUVs allows you to go for days or, in some exceptional cases, a week, whereas gliders have endurances that range from weeks to up to six months. This is possible since they travel at about .3 meters per second—a little more than ½ knot — so power consumption is very low, but in order to make headway, they also have to move up and down which creates their typical saw-tooth motion pattern. As a result, they can't perform level flight. I wanted to address this issue and one of my students, Brian Claus who came out of the Mechatronics program at the University of Victoria, took this problem on for his master's degree research. We started working on it in the fall of 2008.

The main feature of the Hybrid glider is the propulsion module, which is optimized for low power consumption and high reliability. In order to achieve these two goals, all of the drive train components—the motor, gearbox, coupling and propeller—are selected with reliability and overall system efficiency in mind. We performed tests in the Marine Institute's flume tank, which allowed testing in a variety of realistic conditions, in the tow tank at Memorial University and finally at the Marine Institute's Marine Base in Holyrood. In January and February, we flew the glider in open water at a depth of 20 to 50 meters. From all these tests we determined that the drive is at least as efficient as a buoyancy-driven glider; it uses the same or less amount of power per distance travelled. Having easy access to those facilities allowed incremental development. In order to develop this unique glider capability, we have made shameless use of these facilities!

The other feature on this glider is an ice–profiling sonar, which is tuned to get reflections off ice. The sonar tells you the distance from the reflector. The plan is to have a glider criss-cross underneath an iceberg to get a rough shape estimate of what it looks like below the waterline. We worked with ASL Environmental Sciences of Victoria to get a sonar that fits into the glider, and the National Research Council developed the software to acquire data from it.

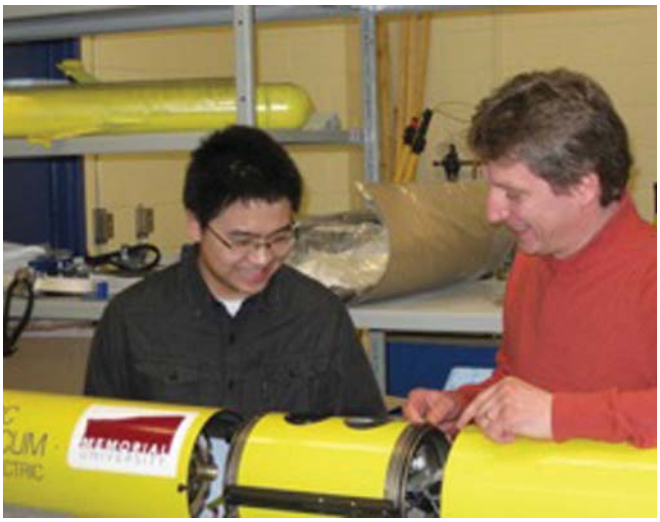
We haven't tested it under ice yet, but it gets consistent range measurements off the water surface.

Since the trials were successful, what's the next step?

Bachmayer There's an agreement with Teledyne Webb Research of Falmouth, Massachusetts to commercialize this technology.

What other considerations were you dealing with in this project?

Bachmayer The other problem we worked on is navigation. Power is the source of many challenges with gliders. There are severe power constraints so you cannot afford a very sophisticated navigation system like you would use on a large AUV—an inertial navigation system (INS) with a north-seeking fiber optic gyro. And because of the low power restrictions, there's very little hope of communicating over a long distance and at a bandwidth that's high enough to control the vehicle remotely. On a larger vehicle you could install an INS aided with a Doppler Velocity Log (DVL), which would tell you pretty accurately where the vehicle is, relative to your starting point on the seafloor as long as you stay within the DVL range of the seafloor. You could integrate accelerations and rates from a low power inertial measurement unit, but in terms of cost, power and ultimately accuracy it currently is not feasible for fully submerged operations, that is, without surfacing and the aid of GPS. You need to use "all your senses (sensors)" to figure out where you are, meaning that you have to utilize and combine other measurements you're acquiring along the way anyway. There won't be a single solution. What helps, is that if you're using the glider to support physical oceanography most of the time you're not looking for sub-meter accuracy as you would be if you were trying to locate a mine. So knowing the location within a hundred meters is adequate and in some cases, within 500 meters is OK, if you travel over distances of hundreds of miles.



What are some of the other pressing challenges in underwater vehicle development?

Bachmayer Besides power, communication and navigation, what's emerging now is autonomy. If you cannot have a high enough bandwidth to allow communication, you have to give more intelligence to the vehicle. We're just in the infancy of autonomous decision-making.

What about improving underwater vision?

Bachmayer In areas that are very structured like the offshore, you can have, for example, a CAD model and use acoustics or, if there is enough visibility, regular cameras, and combine all the data to produce synthetic vision — a combination of what you know a-priori about the environment and smaller subsets of what you actually detect and identify. Often the full scene can't be observed, but by comparing some of the key aspects with the CAD files or other representations of the environment, the vehicle would generate a synthetic view — a merging of virtual reality with reality.

What differentiates this lab from other AUV labs?

Bachmayer A large part of what we're doing is we're putting our systems through test loops in our tanks. We test them and focus on optimizing the design and then we put them in the ocean. Again, shameless use of the facilities! We already had a unique, world-class test-tank infrastructure in St. John's, but the Holyrood Marine Base provided the missing link between the tanks and the open ocean.

Five Minutes With

Barbara Fogarty

Coordinator Advanced Marine Technology Program – SeaChange Management Unit

by Greg Trauthwein

At OceanTech Expo 2011, May 17-19, 2011, in Newport, Rhode Island Dr. Barbara Fogarty will lead the way as the Keynote Speaker for the 2011 Industry Outlook Panel Sessions. Marine Technology Reporter recently spent some time with Dr. Fogarty for her insights on emerging subsea technology trends.

Please provide a brief synopsis of yourself & your career.

Fogarty A native of Dublin City, Ireland, I graduated with a B.Sc. in Environmental Science and Technology from Sligo Institute of Technology in 1998 and a Ph.D. in Environmental Analytical Chemistry from Limerick Institute of Technology in 2002 followed by a Post Doctoral Position in The University of Kansas where I focused on the development of microseparation systems for biological and environmental analysis. In 2005, I moved back to Ireland and joined Tyndall National Institute in Cork, where I worked on the development of integrated microsensor systems combining miniaturized sampling, preparation and detection components for environmental monitoring. I was appointed to my current position in 2009 and currently coordinate Ireland's National Marine Technology Program on behalf of the Irish Marine Institute.

What are your responsibilities in your position?

Fogarty The ultimate aim of the National Marine Technology Program is to support the development of next generation technology solutions for marine related sectors and their delivery to global markets. One of my key responsibilities is to consolidate and build Ireland's current capacity in the area of marine technology specifically sensing, information and communication systems. A key element involves actively networking with research groups, industry and Government Agencies Nationally and Internationally to support the development of a critical mass of activity in the development of ICT solutions for Marine Related Sectors. This is currently achieved through the facilitation of targeted networking sessions, workshops and working groups to identify key areas of opportunity for Irish based companies and academic researchers. We are specifically focused on to raising awareness of current activities and expertise, identifying new project development opportunities and research partners and facilitate industrial and academic researchers to target appropriate funding to resource new activities. I also monitor the progress of projects funded directly by the Marine Institute and other organisations and act as a National Contact Point for National Activity in the area of marine technologies.

Please provide a brief overview of the top two or three programs/initiatives of which you are currently involved.

Fogarty At program level we are currently supporting a number of national initiatives in the area of marine ICT. One of our flagship infrastructure projects is called SmartBay. Originally inspired by related activities of our colleagues in Newfoundland and Labrador, the 'Irish' SmartBay was established as a pilot project in 2008 off the west coast of Ireland to provide a real world testbed for the development of technology products and services for the marine sector. Key industry partners who have trialed technologies in the infrastructure to date include companies not immediately associated with the marine sector such as IBM who have developed web portal interfaces and streaming data analytics for subsea acoustic monitoring applications and Intel who recently complete testing a

"From a technology point of view there are still significant challenges for the development of cost appropriate reliable autonomous sensor and data management networks that can survive extended deployment and present an accurate picture of the challenging and dynamic conditions presented by the marine environment. There are a range of relatively mature technology platforms such as new materials, sensor platforms and software systems originally developed for sectors other than marine such as medtech, telecommunication networks and even finance, currently being adapted to solving real world issues in marine sectors."

Dr. Barbara Fogarty

A “Smart Bay” Buoy

WiMax communication system for SmartBay which now provides high bandwidth data backhaul capabilities for marine sensing. The SmartBay infrastructure continues to act as a catalyst for new collaborative technology development with a growing consortium of MultiNationals, Indigenous Enterprises and the academic researchers from both the ICT and marine sector. SmartBay forms a critical part of the national ecosystem that continues to attract foreign direct investment in the area of CleanTech and Marine Technologies. A consortium of Industry, Academic and agency partners was recently awarded 4M Euro to establish the SmartBay infrastructure as a National Test Facility for Marine ICT. SmartBay is also a flagship infrastructure in the National SmartOcean Strategy which seeks to establish Ireland as a world leader in the delivery of ICT enabled products and services to the global marine sector. The strategy seeks to position Irish based companies to deliver specialist hardware and software software systems supported by a network of world class physical and digital testbed infrastructures including SmartBay, Ocean Energy Test Facilities and a range of Digital Marine Data Resources including datasets from the National Seabed Survey. We are currently facilitating a number of industry led sub groups focused on the development of new technologies for the areas of marine monitoring systems, digital ocean engineering and marine security and surveillance systems.

Can you give us a "sneak peak" as to what you plan to discuss during your keynote speech at this year's OceanTech Expo in Newport, Rhode Island?

Fogarty I am delighted to participate in this year's program of events in Newport which represents an exciting opportunity to highlight the wealth of activity underway in Ireland in the area of marine sensing and ICT. I plan to outline some of the projects underway in the SmartBay infrastructure and look at some of the key areas of interest for Irish companies and research groups engaged in Ireland's emerging SmartOcean sector. I am also especially pleased to participate in the Newfoundland and Labrador Pavilion stand where we for the second year running we will have a stand

detailing the operational and research activities of the Irish Marine Institute and provide further information on the range of expertise and activities in Ireland's SmartOcean network. I hope to act as a key liaison for OTE participants who may be interested to engage with the Irish and European Partners to explore the opportunity to develop new projects in this space.

Industry, academia and government all play distinct, important roles in advancing subsea technology: What do you think are the key point to get these groups working in unison towards a common end?

Fogarty I consider myself extremely privileged to work at the interface of an exciting and multidisciplinary area of technology development. More than ever before there is a shared understanding of the role each of the various players has in the realization of technology cluster initiatives and the need to work with a range of stakeholders to articulate and achieve a common development goal. Ireland has a strategic advantage in the formation of research clusters due to our small geographical area which facilitates valuable networking and collaborative opportunities for industry, researchers and government (by comparison, our terrestrial area represents a mere 10% of our 220 million acre marine resource). Ireland also has many of the players from across the value chain of global ICT and marine and related sectors including Offshore Energy, Environmental Monitoring and Shipping Security. This allows us to identify end user requirements and associated research and development opportunities and to engage a range of expertise from the development of sensor hardware through to software solutions required. We also have a range of specialist government organisations including the Marine Institute, Sustainable Energy Authority of Ireland, the EPA, the Naval Service, National Utility Companies and others engaged in the provision of operational services and cutting edge research activities who are also willing to support to industrial and academic researchers developing new technologies through the provision of access to specialist expertise and infrastructure. A significant proportion of this activity has been supported by national industrial development and research funding agencies and builds on a legacy of strategic national investment in marine science and ICT over the last number of years. From an economic and environmental perspective government also has a crucial role to play in the development of marine enterprise through the establishment of a supportive policy framework that enables sustainable economic development of marine enterprise while ensuring protection of the natural marine resource.

What technologies do you see coming along today or the next few years that will have a "game changing" effect on the way we conduct our subsea business?

Fogarty From a technology point of view there are still significant challenges for the development of cost appropriate reliable autonomous sensor and data management networks that can survive extended deployment and present an accurate picture of the challenging and dynamic conditions presented by the marine environment.

"Fogarty" Continued on page 46

Set for Philadelphia

National SeaPerch Challenge

On May 24-25, 2011, the first-ever National SeaPerch Challenge, hosted by ONR, SNAME, ASNE and Drexel, and sponsored this year by the Naval Engineering Education Consortium (NEEC), will be held on the campus of Drexel University where 50 middle and high school student teams from school districts and after school clubs across the country will convene to match skills with their SeaPerch underwater robots in a series of challenging underwater competitions. The SeaPerch program was designed for students to learn some of the principles of science and engineering by assembling, testing, operating and competing with their own remotely operated ROV's. Because of ONR's commitment, the SeaPerch Program, which introduces middle and high school students to STEM (science, technology, engineering and mathematics) through underwater robotics, has grown exponentially, reaching over 26,000 students in four years. With more than 2000 trained teachers and mentors participating as well, students are learning through hands-on activities and by following an established curriculum

Ensigns Natalya Aoki and Patrick Cooper assemble a SeaPerch underwater vehicle at the U.S. Naval Academy.

Judges Needed

Should you be interested in participating as a judge on May 24, please visit the www.seaperch.org website, and for assistance in registering to be a judge, or for any questions about the event, please contact Phil Kimball at pkimball@seaperch.org or call 201-310-2607.

to discover the excitement of STEM as a potential future career path. The focus of the program is to introduce STEM to a diverse population, so participating in the National Challenge will be students who have been directly exposed to STEM through SeaPerch and are coming from all over the country - from inner city Baltimore to rural Mississippi to Native American reservations in Minnesota to Alaska and Hawaii.

This national event will provide an opportunity for the students to compete with their peers in a series of underwater challenges, and to present their designs and adaptations in a juried poster event. Later they will visit the Independent Seaport Museum (ISM) and attend the gala Awards Dinner there that evening. Prior to the Awards Dinner, the students will have the opportunity to take part in tours of the historic ships, USS OLYMPIA and the BECUNA (SS-319), and view the many exhibits at the ISM. The next day, students will attend the Intelligent Ship Symposium (ISS IX) sponsored by the Delaware Valley Section of ASNE. The hosts of the Challenge encourage their members and the general public to visit the Challenge in Philadelphia on Tuesday, May 24, to find out what the SeaPerch program is all about and to cheer on the students competing for prizes. This will be a great opportunity for many to meet first-hand our next generation of scientists and engineers, to witness the students' enthusiasm and to share in the excitement of the pool and poster competitions. The Challenge is taking place at Drexel University's Daskalakis Athletic Center at 33rd and Market St. in Philadelphia. The day starts with opening ceremonies at 8:45 a.m., immediately followed by the students' pool competition and the poster presentations. Susan Nelson, Executive Director of SeaPerch, summed it up by saying, "the first National SeaPerch Challenge is the fulfillment of ONR's vision to showcase future STEM talent on the national stage, and this particular event would not have been possible without the generosity of the NEEC grant. Experiencing in person the benefits of hands-on learning, innovation and competition and sharing the excitement and enthusiasm generated by these students is be proof positive of the resounding success of the ONR-funded SeaPerch Educational Outreach Program."

"The first National SeaPerch Challenge is the fulfillment of ONR's vision to showcase future STEM talent on the national stage, and this particular event would not have been possible without the generosity of the NEEC grant."

Susan Nelson,

Executive Director, SeaPerch,

MIT Origins of SeaPerch

SeaPerch is an underwater Remotely Operated Vehicle (ROV) assembled by students as part of a STEM (Science, Technical, Engineering, and Mathematics) curriculum. As student teams build the SeaPerch from kit components, they follow a build curriculum that teaches scientific and engineering concepts while encouraging students to work together in teams, and, most importantly promotes science and engineering as fun.

Created by Harry Boehm and Vickie Jensen, authors of "How to Build an Underwater Robot," the SeaPerch ROV was created as hands-on build curriculum by the Massachusetts Institute of Technology (MIT) and was initially funded by the Navy's Office of Naval Research (ONR) through MIT as a teacher-training program. The program was introduced to teachers in New England and expanded to several other school districts outside of the immediate area. The Navy's Office of Naval Research (ONR), through the National Naval Responsibility for Naval Engineering (NNRNE), providing an initial seed grant aimed at determining SeaPerch's potential to play a larger part in its Outreach efforts. This initial project was deemed successful, and ONR has continued to broaden its support of the SeaPerch program, which has now become their signature K-12 Outreach program.

The Society of Naval Architects and Marine Engineers (SNAME), a professional technical society with a strong history of commitment to education and scholarship in the maritime industry, was tapped by ONR to lead the SeaPerch effort and determine the program's viability for expansion to a national program. The SNAME/ONR partnership began in the fall of 2007 with just over 700 students and 38 teachers trained. At the end of 2009, just two and a half years later, 6,378 students and 257 teachers had participated in the program, doubling each year.

OceanTech Expo

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In the water this year at OceanTech expo:

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SeaBotix - vLBV 300
Sea Sciences, Inc. - Acrobat Model LTV-50X Tow Vehicle
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PiezoElectric Ceramics • Polymers • Ceramic/Polymer Composite Devices

Expanding Markets

By B.L. Gupta, Senior Analyst and Dr. Thomas Abraham, President
Innovative Research and Product (iRAP), Inc.

Piezoelectric ceramic elements have been used in the military for several decades. However, with new generation applications, the larger usage has shifted from military to commercial and consumer-related applications.

Piezoelectricity is electric polarization produced by mechanical strain in certain crystals, the polarization being proportional to the amount of strain and changing sign with it. The reverse is also true: an electrical polarization will induce a mechanical strain in piezoelectric crystals.

Practical use of the piezoelectric property of quartz was made in 1916 by Langevin, who developed an ultrasonic sending and receiving system. A piezoelectric quartz crystal was set into oscillation by an electrical signal, and the high frequency mechanical vibration was transmitted through water to a reflecting body. A second quartz crystal received the reflected vibratory energy (ultrasound) and, from the time of lapse between sending and receiving, the distance from the source to the reflecting body could be calculated. This major application of piezoelectricity was the forerunner of modern-day sonar.

In the strictest sense, crystals are the only materials that can demonstrate piezoelectric properties. Quartz, Rochelle salts and tourmaline were the earliest known highly polar natural piezoelectric crystals. In common usage, however, the term piezoelectric now also is used to characterize certain ceramic and polymer materials. These ceramics and polymers do not exhibit piezoelectric properties in their natural state, but rather only after the temporary application of a strong electric field. The process of making polycrystalline ceramics and polymers piezoelectric is called "poling" and is analogous to the magnetizing of a permanent magnet.

Ceramic and Polymer Materials Used

The types of piezoelectric ceramics available are: barium titanate, lead zirconate titanate (PZT), lead metaniobate, bismuth titanates, sodium potassium niobate and lead titanate. Foremost of these has been barium titanate, which dates from the early 1940s and still has some uses today. It is primarily used in the capacitor industry; however, it has largely been supplanted by the PZTs. PZT materials are available in a wide variety of compositions that are optimized for different applications. PZT is a mixture of lead zirconate ($PbZrO_3$) and lead titanate ($PbTiO_3$) and has the perovskite structure. Various additives and Ti/Zr ratios may be used to yield material that has one or more desired properties, such as high piezoelectric activity, low loss or temperature and time stability. A leading alternative to PZT is polyvinylidene difluoride, or PVDF, a highly non-reactive and pure thermoplastic fluoropolymer. Ceramic/polymer composites are newer piezoelectric materials.

Applications Widen

The reasons for the acceptance of the piezoelectric ceramics are (1) the high piezoelectric activity and high permissivity and (2) the ease of fabricating the material into a very wide variety of sizes and shapes. These range from sheets a few mils thick to large rings, cylinders, bars, and plates. Such ceramic elements can be further combined to produce even larger structures, e.g., wedge-shaped bars assembled to make a large ring, shaped plates to form a sphere, or rings stacked to make a long cylinder.

With an increase in industry automation, along with a consumer taste for sophisticated gadgets, there has been a substantial rise in the use of piezoelectric devices. There

also has been a surge in applications, e.g., medical electronics, ultrasonics and sensors. The emerging markets are in computer-related areas such as micro-actuators for hard disks and piezoelectric transformers for laptops. Military use has been declining as industrial and consumer-related applications grow.

New applications are emerging for piezoelectric devices, which include actuators, ultrasonic motors, sensor arrays for structural health monitoring, transformers and micro-energy harvesting devices which are an alternative to batteries in microwatt devices. Other new applications include high-resolution ultrasonic medical imaging, computer disk drives, and accelerometers in mobile phones and notebooks.

Unlike other piezo devices, commercialization of piezoelectric-operated actuators and motors is likely to proceed in those markets where the specific advantages of high torque, high precision and lack of magnetic interference are particularly useful. When the costs can be lowered to competitive levels, and remaining technical problems such as frictional wear can be solved, piezoelectric motors may also become candidates in areas such as automotive accessories, where very high volume markets are possible.

Table 1 (on page 30) shows a list representing some of the applications currently existing in the military, automotive, commercial, medical and consumer markets.

Piezoelectric Ceramics Usage in Sonar Continues

Sound Navigation And Ranging — or SONAR — is a technique that uses sound propagation under water (primarily) to navigate or communicate or to detect other vessels. There are two kinds of sonar, active and passive. The term sonar is also used for the equipment used to generate and receive the sound.

Sonar may be used as a means of acoustic location. Acoustic location in air was used before radar. Sonar may also be used in air for robot navigation while SODAR upward-looking in-air sonar) is used for atmospheric investigations.

Active sonar uses a sound transmitter and a receiver. Active sonar creates a pulse of sound, often called a "ping," and then listens for reflections (echoes) of the pulse. This pulse of sound is generally created electronically using a sonar projector consisting of a signal generator, power amplifier and electro-acoustic transducer/array, possibly with a beam former. Active sonar is also used to measure distance through water between two sonar transducers or a combination of a hydrophone (underwater acoustic microphone) and projector (underwater acoustic speaker). Active sonar, when used with multiple transducers/hydrophones/projectors, can calculate the relative positions of static and moving objects in water.

Passive sonar listens without transmitting. It is often employed in military settings, although it is also used in scientific applications, e.g., detecting fish for presence/absence studies in various aquatic environments. In the very broadest usage, this term can encompass virtually any analytical technique involving remotely generated sound, though it is usually restricted to techniques applied in an aquatic environment.

Passive sonar systems may be used in:

- Warfare – Anti-submarine warfare, torpedoes, mines, mine countermeasures, submarines, aircraft, underwater communications, ocean surveillance, underwater security, hand-held sonar, intercept sonar
- Civil –applications - Fisheries, echo sounding, net location, ship velocity measurement, ROV and UUV, vehicle location
- Scientific applications – Biomass estimation, wave measurement, water velocity measurement, bottom type assessment, bottom topography measurement, sub-bottom profiling, synthetic aperture sonar, parametric sonar
- Sonobuoy (a combination of sonar and buoy) is a relatively small (typically 4⅞ inches, or 124 mm, in diameter and 36 inches, or 910 mm, long) expendable sonar system that is dropped/ejected from aircraft or ships conducting anti-submarine warfare or underwater acoustic research.

The success of piezoelectricity in sonar applications has created intense development interest in piezoelectric devices. Over the next few decades, new piezoelectric materials and new applications will be explored and developed.

TABLE 1

Piezoelectric Ceramic/Ceramic Composite Applications in Industries

MILITARY	COMMERCIAL	MEDICAL
SONAR	Ultrasonic cleaners	Ultrasonic cataract removal
Hydrophones	Ultrasonic welders	Ultrasonic bubble detectors
Sonobuoys	Ultrasonic degreasers	Ultrasonic therapy
Depth sounders	Ultrasonic touch sensors	Ultrasonic transducers
Targets	Ultrasonic probes	Insulin pumps
Fuse devices	Thickness gauging	Fetal heart detectors
SAW devices	Flaw detection	Flow meters
Sub bottom profiling	Seismic sensors	Disposable patient monitors
Ringers	Integrated sensors	Ultrasonic imaging
AUTOMOTIVE	Level indicators	Vaporizers
Knock sensors	Pyroelectric detectors	**CONSUMER**
Wheel balances	Ultrasonic drilling	Humidifiers
Radio filters	Vibrators	Gas grill igniters
Seat belt buzzers	Geophones	Telephones
Tread wear indicators	Delay lines	Smoke detectors
Air Flow	TV and radio resonators	Microwave ovens
Airbag sensors	Airplane beacon locators	Jewelry cleaners
Fuel atomization	Ignition systems	Phonograph cartridges
Tire pressure indicators	Sensors (impact, humidity, pressure and position)	Speakers
Spark ignition	Relays	Cigarette lighters
Audible alarms	Ink printing	Lighting security
Keyless door entry	Alarm systems	Musical instruments
Interior light movement	Structural health monitoring	Ultrasonic sewing
COMPUTER	Strain gauges	Squiggle motors for camera phones
Micro actuators for hard disk	Smart materials for aircraft wing	Electronic shock absorbers for skies
Transformers for Notebook	Precision mechanics	Robots and toys
Semiconductor Equipment	HVDC Building Control systems	Toys
Micro and Nano Lithography	Noise and vibration damping	Microphones
Data storage components	Non-destructive testing	Headphones
Print heads	Vibration measurements	Beepers in watches and other electronics

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Commercial and Civilian Market Expands

The piezoelectric device market sector is not just a single sector, but rather comprises a number of sectors with distinctly different characteristics. The sectors of most significance are:

- high production volume, piezoelectric device sector consisting of generic piezoelectric devices such as actuators, motors, sensors, accelerators, transducers for ultrasonic medical imaging and non-destructive testing acoustic devices, Lengevin actuators for ultrasonic welding and cleaning, ceramic resonators, and miscellaneous types of devices designed for special applications such as transformers, vibration and noise cancellation in structures limited to different grades of piezoelectric crystals, ceramics such as PZT, PVDF and composites;
- sonars for military and civil use; and.
- niche applications such as energy harvesting, where piezoelectric devices such as generators offer a unique competitive advantage.

Piezo devices also include ultrasonic motors (USMs), which offer a high potential for miniaturization. These actuators produce no magnetic field since the excitation is quasi-electrostatic. Through their specific advantages compared to conventional electro-magnetic motors, USMs fill a gap in certain actuator applications. A key advantage of USMs over electromagnetic motors is their compactness, i.e. their high stall torque-mass ratio and high torque at low rotational speed, often making speed-reducing gears superfluous. Additionally, with no voltage applied, an inherent holding torque is present due to the frictional driving mechanism. It is also worthwhile to mention that their compactness and the high frequency electrical excitation make quick responses possible.

Innovative Research and Products (iRAP) had published an industry and market analysis, focusing on key piezoelectric ceramic, polymer and ceramic/polymer devices and provided the size and growth of different market trends and industry analysis. The report provides a detailed and comprehensive analysis of the markets according to piezoelectric devices, applications and regions.

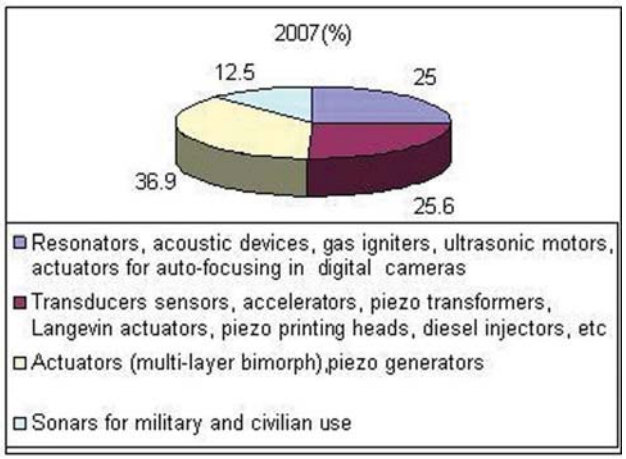
Global Industry Structure

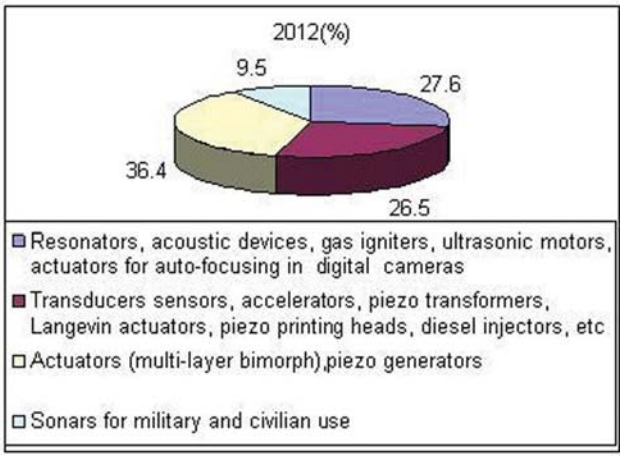
The global piezoelectric ceramic, polymer ceramic/polymer composite devices industry is characterized by about sixty producers and suppliers of these elements and hundreds of piezoelectric device producers. Although, the largest users had been the military for applications such as sonar, sonobuoys and hydrophones, commercial and consumer applications have now taken over the lead. With an increase in industry automation, along with a consumer taste for sophisticated gadgets, there has been a substantial rise in the use of piezoelectric devices. There also has been a surge in applications, e.g., medical electronics, ultrasonics and sensors. The emerging markets are in computer-related areas such as micro-actuators for hard disks and piezoelectric transformers for laptops. Therefore, the military use has been declining at the expense of industrial and consumer-related applications.

Over the next several years, there should be significant growth opportunities for piezoelectric actuators in the biomedical, semiconductor, data storage, aerospace and automation arenas. A well-organized piezoelectric motor business with coordinated, integrated organizations in key regions of the world, a diversified but synergistic product offering, technical expertise in key piezoelectric technologies, and the ability to provide value-added piezoelectric solutions is particularly well-positioned to exert a highly significant influence in the industry and to achieve robust growth. This industry segment contains many relatively small companies as well as piezoelectric-focused organizations within some very large companies; in such a situation, a company that provides global piezoelectric solutions across multiple, key market segments is in a superior competitive position in the marketplace. et dynamics (continued)

Ever since nanotechnology and biotechnology began being well funded by industry and governments, the interest in piezo motion technology has steadily risen. The need of nano-imprinting, scanning microscopy, microlithography and automated alignment has opened new market areas in piezo driven nanopositioning technology, parallel metrology, parallel kinematics, active trajectory control, and covers new control algorithm for vibration suppression and tracking error elimination and their benefits for the users. Companies targeting customer base include largely of academic institutes, government and research laboratories focused in nano fabrication, fiber and integrated optics, photonics, semiconductors, data storage, microscopy and metrology, where nanometer level positioning is of prime importance. Many companies are also OEM customer oriented.

Market Share for Piezoelectric Devices by Type for 2007 and 2012





Source: iRAP, Inc.

The Global Market for the existing 11 generic types of piezoelectric devices had reached $10.6b by 2007, and is expected to reach $19.5b by 2012

TABLE 2

Global Market Size/Percentage Share for Piezoelectric Operated Devices by Product Type, 2007 to 2012

Product/Type	2007 ($ millions)	2007 (%)	2012 ($ millions)	2012 (%)	AAGR % '07-'12
Resonators, acoustic devices, gas igniters, ultrasonic motors, actuators for auto-focusing in digital cameras	$2,670	25.0%	$5,381	27.6%	15%
Transducers sensors, accelerators, piezo transformers, Langevin actuators, piezo printing heads, diesel injectors, etc.	2,726	25.6	5,175	26.5	13.6
Actuators (multi-layer bimorph), piezo generators	3,920	36.9	7,100	36.4	12.6
Sonars for military and civilian use	1,325	12.5	1,837	9.5	6.7
TOTAL	**$10,641**	**100%**	**$19,493**	**100%**	**12.9%**

Source: iRAP, Inc.

Companies Serving this Market

Airmar Technology Corporation
Airmar Technology Corporation manufactures marine and industrial sensors. Airmar products include Piezoflex™ polymer PVDF transducer materials, hydrophones, speed sensors for personal watercraft, and multi-beam arrays for swath bathymetry.

Email: sales@ airmar.com
Web: www.airmar.com

APC International, Ltd.
APC is a global manufacturer and supplier of high quality piezoelectric ceramics and piezoelectric products.

Email: APCSales@ americanpiezo.com
Web: www.americanpiezo.com

CeramTec AG
CeramTec AG is a company of Rockwood Holdings Inc. with headquarters in Princeton, New Jersey, USA. Rockwood Holdings focuses on specialized chemistry and high-performance materials. The company also produces industrial ceramics. Their product range includes piezo ceramics

Email: info@ ceramtec.de
Web: www.ceramtec.de

Channel Industries
Channel Industries, A Division of Channel Technologies Group (CTG) is a custom manufacturer of piezoelectric elements in lead-zirconate and barium titanate compositions. Since 1959 Channel Industries ceramics have been at the heart of thousands of underwater acoustic applications and systems. Serving military and commercial applications worldwide for over 50 years.

Email: ciisales@ channeltech.com;
Web: www.channelindustries.com

Channel Technologies Group
Channel Technologies Group (CTG) designs, develops, and manufactures high-quality piezoelectric ceramics, underwater and ultrasonic transducers, and underwater acoustic equipment, including sonar systems, navigation systems, range systems, and custom acoustic solutions. Serving military and commercial applications worldwide for over 50 years.

Web: www.channeltechgroup.com

CTS Electronic Components, Inc.
CTS Electronic Components manufactures a wide range of products based on proprietary formulations of the naval standard PZT5A and PZT5H materials. Their product list include piezo elements for medical ultrasound imaging transducers, piezo ink jet heads, hydrophones, micro pumps, bimorphs, actuators, and smart/intelligent sensors.

Email: PEPSales@ CTSWireless.com

EDO Cor. Electro-Ceramic Products Div.,
Underwater Acoustic Transducers and Arrays:. EDO's program involvement includes wide aperture arrays, SQR-19 and TB-29A towed arrays, depth sounder and underwater telephone arrays. EDO manufactures motion sensors for use in sonar. Depth Sounding Sonars: The U.S. and other navies worldwide rely on EDO to provide precise and dependable depth sounding sonars for safe navigation. EDO has supplied all of the U.S. Navy's standard AN/UQN-4A depth sounders and has recently begun the rapid development and production of the AN/BQN-17A secure depth sounder, a more rugged COTS depth sounder with stealth features for the U.S. Navy Submarine Force. Underwater Telephone

Apart from this, they are also looking forward to work with conglomerates focusing on optical fiber laying. In future, companies which enjoys strong partner relationships with government agencies and academic institutions who can provide advanced, customized and cost effective solutions to geographical locations, and those who can reach out to customers more effectively, address their requirements precisely and customize the products will have greater advantage to hold leadership position.

Japan is a world leader in mass produced low-voltage piezoelectric ceramic materials. Its piezoelectric ceramic industry is large and stable. It is aimed at standardized mass production elements, such as:

- resonators and filters (ceramic and SAW);
- buzzers;
- audio transducers; and
- alarms.

Excellent technology and superior production techniques allow the Japanese to produce these high-volume elements at very low prices.

The leading Japanese piezoelectric ceramic manufacturers are, Epson, Kyocera Keinski, Matsushita Electric, Murata Manufacturing, NGK Spark Plug Company, TDK, and NEC-Tokin.

European companies such as Physik Instrumente, Cedrat Technology, 1 Ltd., Morgan Electroceramics, Noliac, EPCOS, Ceram Tec AG, Ellepteck Resonant and a dozen others are trying to maintain the second position in the world market, close to China.

China, Taiwan, Korea and the rest of the world are targeting low cost, high volume devices like resonators, buzzers, speakers used in mobile phones, ultrasonic motors used in digital cameras and transformers and hard disks as used in laptops.

North America, like Europe, enjoys a unique position in research related to application of PZT, PVDF and composite materials. Most U.S. companies are engaged in manufacturing high technology, high value piezoelectric devices like sonars, nano-positioning motion control devices, transformers, accelerometers, energy harvesting devices, sensors and switches.

Research Trends

In terms of R&D, several research organizations are working with materials and deposition techniques to create piezoelectrics with thicknesses ranging from microns to millimeters. Materials being explored include:

- lead zirconate titanate (PZT),
- zinc oxide (ZnO), and

- polyvinylidene fluoride (PVDF) polymer films.

Piezoelectric device research focuses on the complex integration of novel materials with electronics for sensing and control. For example, a micro-scale energy converter, based on acoustic resonance principles, integrates the electronics for power conversion and control together with the piezoelectric devices.

Ultra-precise positioning systems, actuators, sensors and motion controllers are principal components of instruments such as critical-dimension measurement tools, profilometers, scanning probe microscopes, optical microscopes, nano-automations and robots. There are tools used in manufacturing and test operations that involve ultra-precision machining, inspecting and testing of parts.

Future research trends will be divided between upsizing in space structures and downsizing in office equipment. Further downsizing will also be required in medical diagnostic applications such as blood test kits and surgical catheters. Key development trends will be integration and hybridization. Piezoelectric thin-films compatible with silicon technology will be much of the focus in microelectromechanical systems.

Global Market

Markets for piezoelectric ceramics, polymers and ceramic/polymer composites have been expanding. New applications have been emerging for piezoelectric devices, which include actuators, ultrasonic motors, sensor arrays for structural health monitoring, transformers and micro energy harvesting devices which are an alternative to batteries in microwatt devices. Other new applications include high resolution ultrasonic medical imaging, computer disk drives, and accelerometers in mobile phones and notebooks.

Growth in the piezoelectric devices market continues to be driven by increasing demands in camera phones for autofocus mechanisms, piezo-transformers, data storage, semiconductors, microelectronics production, precision mechanics, life science and medical technology, optics, photonics, nano-metrology, robots, toys, HVAC control systems, hand held consumer electronic devices, automotives sensors, ultrasonic transducers for medical imaging and non-destructive testing and vibration related applications, structure health monitoring, ultrasonic welding and cleaning, ceramic resonators for mobile phones and devices used for information and communication technologies. Sonars for military and civil uses and other applications constitute an established market.

Unlike other piezo devices, commercialization of piezoelectric-operated actuators and motors is likely to proceed

Companies Serving this Market (cont)

Systems; the Advanced Swimmer Delivery System (ASDS). EDO also supplies a full range of LF and HF transducers for underwater communications

Email: sales@edoceramic.com,
Web: www.edoceramic.com

EPCOS AG
Epcos' product range includes piezo actuators, resonators, surge arresters and switching spark gaps, sensors and sensor systems, thermistors, varistors, and a wide range of multilayer ceramic components.
Email: webmaster@epcos.com
Web: www.epcos.com

Materials Systems Inc.
MSI designs and manufactures custom sonar transducers and arrays. MSI's piezocomposite technology offers extremely broad bandwidth, high receive sensitivity, high source levels, conformability for curved arrays, and reduced side lobes. The technology has enabled several of the most advanced sonar systems available today. MSI is an ISO 9001 company.
Email: info@matsysinc.com
Web: www.matsysinc.com

Morgan ElectroCeramics Ltd.
Morgan Electroceramics' products include ultrasonic transducers, ultrasonic cleaning, ultrasonic therapy, dental descalers, pre-stressed tubes, ultrasonic sensors, accelerometers, blood pressure sensors, air-in-line sensors (bubble detectors), integrated sensors, fuel level sensors, passive piezo sensors, wheel balancing equipment, and impact sensors.
Email: ruabon.sales@morganplc.com
Web: www.morganplc.com

MURATA
Murata's ceramic processing technology and unique piezoelectric material has led to the development of a line of small and thin ceramic resonators, "CERALOCK," that offer high oscillation frequency and remarkable oscillation tolerance. These products are designed for use as a stable timing source for microprocessors.

Physik Instrumente
PI (Physik Instrumente) L.P., is the US operation of Physik Instrumente (PI) GmbH & Co. KG. PI designs and manufactures nanometer-level motion control products, piezo actuators and systems, power amplifiers and drivers, and controllers for PZT actuators/systems.
Email: marth@pi.ws
Web: www.pi-usa.us

Piezo Systems, Inc.
Piezo Systems specializes in manufacturing bending and extending elements. Piezo Systems' bending actuators are employed in piezo valves, choppers, modulators, fans, tunneling microscopes and soil testers. The company's bending sensors are used in implantable pacemakers and industrial equipment.
Email: sales@piezo.com
Web: www.piezo.com

Piezosystem jena GmbH
Products include piezoelectric actuator-based positioning systems which include nano- and micro-positioning, piezo actuators and nano stages, as well as positioning equipment for customized special systems. .
Email: usa@piezojena.com
Web: www.piezojena.com

in those markets where the specific advantages of high torque, high precision and lack of magnetic interference are particularly useful.

When the costs can be lowered to competitive levels, and remaining technical problems such as frictional wear can be solved, piezoelectric motors may also become candidates in areas such as automotive accessories, where very high volume markets are possible.

The global market for traditional piezoelectric devices is quite mature in applications. However, the global market for new piezoelectric devices will see a robust two-digit growth rate in next five years.

The global market for piezoelectric devices using ceramics, PVDF and ceramic/polymer composites had topped $10 billion in 2007 as shown in Table 2. Among the devices, piezoelectric actuators and motors have the highest growth rates because of their applications in information technology, robotics, biomedical engineering, automotive, ecology and energy engineering.

- Among the nine markets, information technology/robots (31.7%), is the clear leader, followed by semiconductor manufacturing and precision machines (18.6%), sonar (12.5%), and bio/medical (11.1%). Other sectors that complete the total market are ecology and energy harvesting (7%), accelerators and sensors (5.8%), non-destructive testing (5.7%) and miscellaneous (gas igniters, piezo printing heads, telecommunication devices) (4.5%), acoustic devices and resonators (3.1%)
- New devices such as piezoelectric generators will see the highest growth rate, estimated to be 51.5% annually. This category is followed by ceramic resonators (27.5%); miscellaneous applications (high voltage devices-gas igniters, piezoelectric elements in laser mirror alignments, acousto-optic modulators, piezoelectric drivers and piezoelectric amplifiers (19.8%); accelerators and sensors (14%); ultrasonic motors (13.4%); and transformers (13.6%). Ultrasonic motors will see 14.6% growth over five years.
- Traditional devices also will see growth, including acoustic devices (13.6%), actuators for computer disk drives (11.6%); Langevin actuators for welding and cleaning (14.6%); sonars (6.75%), transducers (14%); and gas igniters, piezo printing heads, diesel injectors, and piezo amplifiers (19.8%).
- In 2007, Japan had the highest market share of 26%, followed by Europe with 24%, china with 18%, North America with 14%, Korea with 8% and the rest of the world with 10%. By 2012, china will occupy second position ahead of Europe, with a 22% share of the global market.

MARINE TECHNOLOGY REPORTER

Congratulations

CNO Admiral Gary Roughead
recipient of the 2011

Seamaster Award

CNO Admiral Gary Roughead to accept 2011 Seamaster Award at this year's Ocean Tech Expo Exhibitor's Sunset Reception.

w w w . o c e a n t e c h e x p o . c o m

Conceived as a Commercial Survey Tool, Evolving to a Mine Countermeasures Platform, the Marport SQX AUV and its Application in the

Subsea Battlespace

By Karl Kenny, CEO, Marport Deep Sea Technologies Inc.

Marport Deep Sea Technologies Inc. is the largest sonar company in Canada with 120 employees and operations in St. John's, Newfoundland and in Cornwall, Ontario Canada, as well as in the USA, France, Iceland and Spain. It develops and manufactures sonar products for underwater defense, ocean survey and science and deep sea fishing applications. Marport is the originator of the software defined sonar (SDS) processor, a software-centric sonar architecture implemented on reconfigurable embedded hardware.

In 2006 the company, in collaboration with the National Research Council of Canada (NRC) and Memorial University of Newfoundland, embarked on the development of an autonomous underwater vehicle (AUV) as a test platform for sonar systems under development and, later, as a product in its own right. The first version was developed as a subsea survey tool and the design is now evolving to a vehicle capable of advanced military mine countermeasures (MCM) work. The first version is a compact, medium weight AUV that uses a vertical twin-pod configuration, based on the Woods Hole SeaBED AUV concept, and is designed for inspection and mapping applications in waters down to 500 meters in depth. A large vertical separation between the center of gravity (CG) and center of buoyancy (CB) afforded by the twin pods provides a passively stable platform optimal for

Marport's Karl Kenny on hand for in-water testing of the SQX AUV.

deployment of sonar or optical imaging payloads. A 3D thrust vectoring propulsion system unique to the SQX-500 creates an extremely maneuverable platform, allowing for capabilities such as hovering, crabbing and a zero meter turning radius around the vertical axis. The thrust-vectoring system consists of identical forward and aft rudders each capable of +360° rotation. On each rudder is mounted a thruster and propeller, which in turn is mounted on an elevator assembly capable of +30° pitching rotation. In operation the rudders and thruster elevator assemblies can be configured dynamically by the vehicle control computer to provide hovering and a very high degree of maneuverability.

The design process involved extensive use of the expertise and facilities of the NRC Institute for Ocean Technology (IOT) in St. John's, Newfoundland. These include a 200 meter long, 12 meter wide and 7 meter deep clear water towing tank with a carriage capable of controlled speeds between 0.001 meters / second and 10 meters / second and equipped with a planar motion mechanism (PMM); a cavitation tunnel with a 2.2 meter long, 0.5 meter square test section equipped with propeller thrust and torque dynamometers. Marport worked with IOT's staff of AUV researchers, hydrodynamicists and computational fluid dynamics specialists to develop the overall vehicle and thrust-vectoring propulsion system.

To progress from the initial conceptual SQX-500 AUV design to a prototype design for construction, estimates of hydrodynamic drag and power requirements were necessary. Previously published scientific literature was reviewed to locate existing hydrodynamic drag data for similar designs of each component. This information was a critical input into the initial propulsion system design – propellers and thrusters — and an essential component for an initial performance estimate of the AUV. In order to simplify the estimation process, the hydrodynamic loads acting on the system were evaluated as separate components; cylindrical hulls with ellipsoidal nose cones, vertical rudders, and horizontal elevators. The contributions from these individual components were then summed to estimate the total vehicle forward drag. Previously published scientific literature was reviewed to locate existing hydrodynamic drag data for similar designs of each component.

Cylindrical hull forward drag values were based on published measured data for single pod vehicles. Rudder and

elevator forward drag values were based on standard test data available for NACA airfoils. Forward drag estimates for all components were then combined, and an initial estimate for total vehicle forward drag based on forward speed was produced. These results provided a useful staring point, but as the vehicle design was evolved into a functional prototype design, significant shortcomings were identified, particularly the fact that the data available were only for forward drag; little published data were available for cylindrical hulls in very high angles of attack, such as when the vehicle is crabbing sideways or holding station in a current. As a result, it was decided to perform a series of hydrodynamic drag tests with an accurate scale-model of the SQX-500. A 0.88 scale model of the SQX-500 was constructed and subjected to model testing in the IOT Clearwater Towing Tank.

The three primary maneuvers of the SQX-500 AUV are forward transit, hovering while holding station, and transverse motion or crabbing. In order to provide sufficient hydrodynamic drag data for these maneuvers, three sets of drag tests were performed with the scale model to measure resistance in forward transit, sway and heave. In each set of tests, the angle of attack of the scale model was varied in order to obtain data for the vehicle in all orientations relative to the direction of vehicle motion. Angle of attack was controlled using a yaw table mounted to a tow carriage. These tests have resulted in a large number of drag force data sets for all forward and transverse motions at a large number of angles of attack. This data provided input to the design of the propellers and the thruster, and a 6 DOF motion simulator.

After searching for a commercially available propeller, it was decided to perform a custom design using the scale model resistance data as input. Extensive use was made of the IOT cavitation tunnel (interestingly, a device built by the German Navy in the 1930's for the design of U-Boat propellers and given to Canada as part of reparations after World War II.) The testing showed that the theoretical performance of a custom propeller design (estimated mathematically) was verified with real-world test data; real-world efficiency was up to 70%, agreeing well with theoretical efficiency. It was demonstrated that the custom design and production of a cast urethane propeller is a viable and cost-effective solution for the design of AUV propulsion systems. **An important observation was that high propeller blade rigidity is desirable in this design. As blade deflection increases while under load, performance decreases as the propeller shape deviates from the design.** All remaining aspects of the design and prototype development were performed in the same way – analysis followed by mathematical modeling followed by full or scale model testing using the various state-of-the-art

marine hydrodynamics facilities available in St. John's. The data already collected will be used in the development of future versions of the SQX type and additional work will be performed as design input data requirements arise. The SQX-500 was designed to be a commercial survey tool. During its development Marport has been germinating ideas for other applications, particularly in undersea defence. Working in collaboration with Defence Research and Development Canada (DRDC), a branch of the Canadian Department of National Defence, and with the NATO Underwater Research Centre (NURC), an MCM concept has evolved and is being developed based on the use of a larger version of the SQX type AUV in a multi-agent application. It also includes an underwater ad hoc communications networking system based on disruption tolerant design principles from development partner General Dynamics Canada, a high precision positioning system, a novel interferometric synthetic aperture sonar (InSAS) operating on an SDS processor, with a real time automatic target recognition (ATR) system and a surface Gateway for "acoustic – RF" communications and a navigation reference. The complete system is called Ocean Shield. Because of the MCM requirements the proposed SQX-SAS AUV will have to be larger and heavier than the SQX-500 AUV design and will require enhanced yaw stability for InSAS and additional payload capacity, including additional energy capacity. The propulsion system itself will have to be augmented with larger propellers and possibly two drive/gearbox units per rudder as opposed to one each in the current production version. The naval mine is an efficient force multiplier and is one of the most cost-effective weapons in the naval arsenal. Mines are small, easy to conceal, inexpensive to acquire, need little maintenance and can be easily laid from any platform. Countering threats from sea mines and underwater improvised explosive devices (IEDs) involves the use of robust solutions to detect, classify, and then neutralize these devices.

It is generally recognized that, with the increasing threat from the proliferation of mines and ever decreasing resources for MCM, AUVs provide a promising option for meeting challenging MCM requirements currently and into the foreseeable future. Advantages of AUV-based MCM include potential for operating multiple systems simultaneously (increasing coverage efficiency), low risk to personnel because vehicles are unmanned and can be forward-deployed at safe stand-off ranges and higher sonar data quality. As well as its capability for mine search and disposal, the data received from an AUV reconnaissance mission may be used to assess the limits and characteristics of a mine field, with the intention of establishing diversion routes. The data may also be used for mapping lead-through routes to give safe passage to shipping and amphibious assault vessels.

The classic end-to-end response to a mine threat is often abbreviated as DCLIRN (detect, classify, localize, identify, re-acquire, neutralize). Ocean Shield includes the D, C, L and possibly I capabilities, but not N. An important requirement is the provision of real time communications to manned assets with the information that a mine like object (MLO) has been detected, where it is located and possible specific identifying features. In the case of a positive identification, the end game would be the deployment of another undersea asset to neutralize the object.

The inclusion of the InSAS is noteworthy. The use of a twin pod AUV as a platform for an InSAS has not been done before. In the planned configuration two receive transducers will be attached to each hull, one receiving echoes from the port side of the AUV, the other from the starboard side. On each side of the vehicle, therefore, echoes from the same transmission will be received by two transducers separated by a vertical distance called the interferometric baseline, the basic principle of interferometry. The significance lies in the fact that the SQX twin pod design offers the possibility of a separation distance of up to 1.0 m, which will be much larger, possibly by a factor of 3, than what is used in any other AUV mounted interferometric side-looking sonar system, and will result in a measurement quality higher than that offered by any competitor or even by systems known to be under development. The ATR requirement is particularly salient in the case of an AUV equipped with a high-resolution InSAS. Its purpose is to detect and discriminate targets of interest from the many other naturally occurring or man-made yet benign objects. Ocean Shield will be deployed in 2013 and promises to be a game changing MCM technology suite in the underwater battlespace.

Acknowledgements

This article is based on several papers published in various journals and proceedings by the Marport development team and their collaborators at the NRC Institute for Ocean Technology, Memorial University of Newfoundland, DRDC and NURC.

***Karl Kenny** was formerly a Maritime Surface Officer in the Canadian Navy. For the last 25 years he has been an ocean technology entrepreneur, is a co-founder of Marport and originator of the software defined sonar processor concept.*

Rhode Island — via UPSIDE — Takes the Lead on

Subsea Security

The Rhode Island Economic Development Corp. (RIEDC), in conjunction with the City of Providence Emergency Management Agency (**PEMA, pictured right**), earlier this year hosted an in-water demonstration of a real-time diver detection and response system called UPSIDE at the PEMA Emergency Operations Center. The UPSIDE system is funded by the U.S. Office of Naval Research (ONR), with works on science and technology programs for the US Navy, and is managed by the RIEDC with technical support from the following businesses and organizations:

- **Rite Solutions** – Systems Integrator and Technical Manager
- **Purvis Systems** – Incident Management and Distribution System
- **Smiths Detection** – Digital Video Recorders
- **Raytheon Integrated Defense Systems** (ATHENA system)
- **SoneSys** – Sonar
- **Naval Undersea Warfare Center (NUWC)** – Independent Technical Advisors and demo support.

The UPSIDE system is designed to be **a real-time diver detection system that also classifies targets and delivers critical information to security forces** to determine the response required to manage the threat. "Securing our port facilities and cargo is vital to the growth and stability of our economic infrastructure," said Keith Stokes, RIEDC Executive Director.

Rite Solutions served as the Systems Integrator and Technical Manager for the UPSIDE project, and as such was tasked with bringing together the many disparate piece of equipment – including video surveillance system, high frequency sonars, unmanned vehicles and first responders – and information, melding hardware and data into a cohesive unit designed to efficiently collect and disseminate information via its Rite View 3-D Command and Control maritime visualization system.

According to Dean Balcirak, System Test Engineer, the challenge inherent but not unique to the UPSIDE project was bringing together products and systems from outside organizations into a cohesive system. This was accomplished using an enterprise service bus as the backbone for the data and individual interface translation services, as well as the hands-on expertise from Rite Solutions in performing past commercial projects which required tying together a number of different products and systems.

"This project was really a jumping off point for Rite Solutions," said Rory Hanmer, Lead Software Engineer, "in the use of the enterprise service bus as the data backbone. The hardest part – as always — is linking with other companies, products and systems; each interface has its own particular needs. We provided the conduit to get all of the data on to the enterprise service bus, and in turn to bring the data into the Command and Control System and ultimately, Rite View (TM)."

The ability to test systems 'on the workbench' as opposed to in the water was invaluable, according to Balcirak. "In testing the system, we were linking to the unmanned vehicle system while it was on the test bench at URI," he said. "We were able to test the equipment (including the sonar) before the equipment was in the water, so by the time we got into the water, we were 98% there on the equipment, allowing us to focus on getting good data instead of working out interface bugs.

UPSIDE is currently in Phase 3, meaning that the technology has been integrated and tested; proven as a unit during trial, and ready for market – as a unified system or as individual technologies – for commercial or government customers. According to Hanmer, there are no shortage of potential customers, ranging from port and harbor security, to addressing the multiple threats inher-

(Photo Courtesy: RITE Solutions)

Mike Grzechowiak, Software Project Manager and Technical Lead/Mgr.

(Photo Courtesy: RITE Solutions)

Dean Balcirak, System Test Engineer

(Photo Courtesy: RITE Solutions)

Rory Hanmer, Lead Software Engineer

ent to offshore oil and gas rigs. "We are not limiting ourselves to anything," said Hanmer, "if you have anything you want to protect that's in or under the water, this is an option.

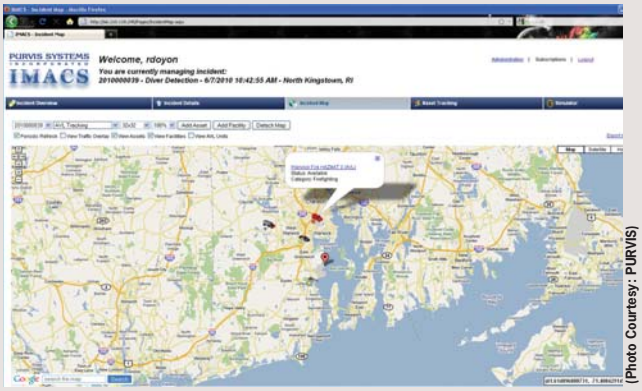
PURVIS Systems contribution to the UPSIDE program is the UPSIDE First Responder System (UFRS). Based upon its robust Incident Management and Control System (IMACS) platform, UFRS is the direct link into the available First Responder community, and is a distributed interoperable management system used to track, share, and manage incident information and assets over a secure wide-area network. UFRS includes an automatic vehicle location (AVL) tracking feature, which provides real-time GPS location for all key First Responder assets. This feature provides the incident manager with the ability to quickly assess the adequacy of the response and to determine whether additional first responders should be requested and where their assistance is needed.

UFRS also includes the PURVIS Emergency Notification System (ENS). PURVIS ENS is a Web-based system that enables organizations to respond quickly in an emergency by sending mass alerts to common communications devices – mobile and landline telephones, PDAs, computers, pagers and more – through broadcast voice and text messaging.

Additionally, PURVIS provided Rite Solutions with engineering support for requirements definition, system design specifications, framework development, systems integration, and scenario development

In addition to hosting the UPSIDE demonstration, PEMA coordinated the resources and inclusion of the Providence Police and Fire Departments, as well as the RI Department of Environmental Management/Law Enforcement Division and the RI State Fusion Center.

What is UPSIDE?



(Photo Courtesy: PURVIS)

UPSIDE is a Command and Control service oriented architecture system designed to provide three principle objectives:

- **an integrated, interoperable test bed environment that allow evaluation of prototype undersea security systems in an end to end security context,**
- **a simulation environment that robust system performance evaluation as well as mission rehearsal and evaluation,**
- **an undersea perimeter defense system that can be operated in a stand-alone mode or integrated into a comprehensive maritime defense system.**

Operating with or without a Tether

Double Eagle

By Edward Lundquist

Unmanned vehicles have become a platform of choice for surveying underwater regions for mines and other objects that don't belong there. Unmanned underwater vehicles (UUVs) come in many shapes, sizes payloads and capabilities. Carl-Marcus Remén of Saab Underwater Systems in Motola, Sweden, said Saab's underwater systems can be used for mine hunting in both a tethered and autonomous mode. Autonomous underwater vehicles (AUVs) offer more flexibility in deploying sensors in dangerous areas. The Finnish Navy will use the Double Eagle for classification and disposal of mines," Remén says. "In some cases, they plan to use Double Eagle as a propelled variable depth sonar (PVDS), using the ROV in front of the ship searching for mines. The Double Eagle series of vehicles combines the flexibility to search for mines or destroy them, and a unique hybrid capability to operate in an autonomous mode without a tether, when needed. The Double Eagle design is scalable, and comes in three sizes, the 360 kg. (800 lb.) Double Eagle MKII; the 500 kg. (1,100 lb.) Double Eagle MKIII; and the slightly larger Double Eagle SAROV Semi-Autonomous ROV.

Different propulsion options, energy packages, and payloads can be selected to virtually customize the Double Eagle for the mission.

According to Remén, the Double Eagle is designed to handle the mine treath, which means extreme low radiated noise and magnetic signatures. The Double Eagle is modular, so the vehicle can be easily upgraded to cope with new threats, or be adapted to work with new and different sensors and capabilities, such as sonar technologies, cameras, or manipulator arms.

"All of the Saab vehicles feature modularity. The battlespace changes all the time, so we need modularity for the vehicle to be able to respond to that particular situation. We focus on having a stable vehicle," said Remén.

The vehicle can operate at speeds up to 8 knots; is very stable; can hover; and is highly maneuverable with 360-degrees of pitch and roll, Remén said.

In autonomous operation, the Double Eagle AUV is called the SAROV (Semi Autonomous ROV), and can be pre-programmed for course and depth using waypoints. The vehicle knows where it is with inertial Doppler navigation and acoustic GPS positioning, and has an obstacle avoidance capability. SAROV can transmit real-time information back to the ship by means of a raised antenna, at ranges of thousands of meters ahead of the mine warfare ship The system has good speed and endurance to be able to operate at safe, extended ranges from the ship to conduct surveillance in areas suspected of mines, or clear a safe "Q-route" for friendly ships to pass through a suspected mine area.

"SAROV can conduct missions greater than ten hours," Remén said. "That gives it a range of as much a 50 nm. away from the host platform."

Once mines are located, SAROV can be configured to carry explosive charges that can be attached to the mine and detonated at safe distances from the ship.

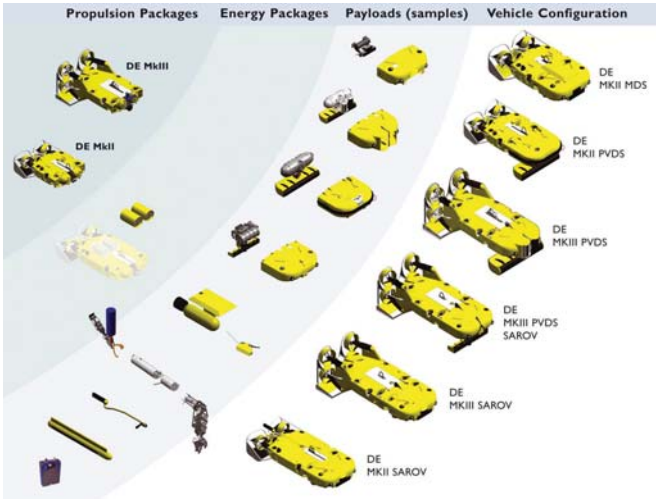
Remén says the Double Eagle can utilize an underwater connection and detachment of the vehicle, so the vehicle does not have to be retrieved on the deck of the ship. "You can connect or detach the cable under water and save a lot of time in operations."

The underwater docking station features an inductive charger, much like electric toothbrushes charger. "This way it can remain on station to conduct surveillance or watch for intruders without being recovered," Remén said. He says that UUVs have come a long way. "We have new autonomous functionalities, and new battery technologies make it possible to operate the vehicle longer in AUV modes. We also have new positioning systems. We are now integrating a new navigation system called Phins 3."

Saab has experience with more than 70 Double Eagle Systems delivered. The Danish Navy is the launch customer for the SAROV version on their mine hunters.

"By adding AUV functions to the Double Eagle, the Danish navy is making more out of the vehicle," Remén said. "They can use the same vehicle for all MCM missions."

The navies of Sweden, The Netherlands, Belgium, France, Finland, Denmark and Australia navies operate the Double Eagle in MCM missions.


Propulsion Packages
Energy Packages
Payloads (samples)
Vehicle Configuration
DE MkIII
DE MkII
DE MKII MDS
DE MKII PVDS
DE MKIII PVDS
DE MKIII PVDS SAROV
DE MKIII SAROV
DE MKII SAROV

"Fogarty" Continued from page 24

There are a range of relatively mature technology platforms such as new materials, sensor platforms and software systems originally developed for sectors other than marine such as medtech, telecommunication networks and even finance, currently being adapted to solving real world issues in marine sectors. For coastal and recreational environments there is a compelling case for the adaptation and development of platforms for real time monitoring of biological and chemical targets using microarray screening technologies currently used by the medical industry. The discovery of new marine derived chemical and biological resources combined with advances in nanotechnology are informing new approaches to antifouling materials designed to prolong operational lifetimes of deployed systems while internet enabled cell phones and mobile devices are being investigated for the delivery of real time updates on changing weather and sea state conditions. Gaming technologies are also being investigated for the visualization of seabed environments and to act as interactive design tools for marine spatial planning and offshore infrastructure development. Many of the game changing developments could be adapted from other sectors to expedite the provision of next generation technology solutions to the global marine community.

What global activities events – from global warming and the retreat of the Arctic; to natural disasters – do you find driving your work today, and why.

Fogarty There are a number of related drivers for the activities of Marine Technology Program and associated outputs. From a scientific perspective there is a need to understand the impacts of human activity and climate change on an the marine environment, a need to improve the spatial and temporal resolution of existing sampling regimes and datasets and a need to understand the dynamic nature of the global marine resource as a critical source of food, transport and renewable energy. From a European perspective legislative and policy drivers including the Water Framework Directive, The Habitats Directive and The Marine Strategy Framework Directive which have specific monitoring requirements. These legislative instruments are already acting as drivers for the development of new technologies and methods to enable efficient monitoring and analysis of marine resources. From a socioeconomic perspective there is also a need to support economic development and sectoral growth and to fully realize the economic value of the global marine resource in a cost effective and sustainable manner. The provision of cost appropriate, fit for purpose technology solutions has a significant role to play in the realization of these goals.

OceanTech Expo'11

OceanTech Expo (OTE) is set for May 17-19, 2011, in Newport, Rhode Island. This year's line-up includes an "Industry Outlook" conference schedule packed with interesting topics — from Subsea Defense to Hydrography to Underwater Vehicles (See Full Schedule on page 48 — with insightful updates from industry leaders in government, industry and academia.

OceanTech Expo (OTE) 2011 brings together the three legs of the subsea technology industry: science, commercial (offshore Oil & Gas) and defense – to discuss the business of ocean technology. OTE is set in scenic Newport, Rhode Island from May 17-19, 2011, and three packed days will include:

- **In-water demonstrations** directly from the dockside exhibition area & OTE's fleet of Research Vessels
- **Networking Opportunities & Social Events**, including the signature "Sunset Reception" on Tuesday, May 17, 2011, in honor of Guest of Honor CNO Admiral Gary Roughead, U.S. Navy
- Informative Industry Outlook Sessions (IOS)
- Hands on training

When: May 17-19, 2011

Where: Newport Yachting Center, Newport, RI

Why:
- In-water Technology Demonstrations; Off the Docks or onboard Research Vessels
- Networking & Social Activities, including the Sunset Reception with special guest CNO Admiral Gary Roughead
- A full Conference Program (see p. 48)

More Info: www.oceantechexpo.com

This year's Industry Outlook Session is headlined by keynote speaker **Dr. Barbara Fogarty** - National Coordinator Advanced Marine Technology Program – SeaChange Management Unit. She coordinates the National Advanced Marine Technology Program on behalf of the Irish Marine Institute. All OTE exhibits, Industry Outlook Sessions and demonstrations are situated directly on the water at the Newport Yachting Center, steps from the booth to the dock.

Industry Outlook Sessions • Schedule of Events

Tuesday, May 17

10:30 am – Noon **Panel: The Expanding Role of Environmental Measurement Systems in the Marine Marketplace**

Session Co-Chairs: Bruce Magnell, Ph.D – Technical Director, Woods Hole Group Archie Todd Morrison III, Ph.D – Senior Ocean Engineer, WHG

Speakers:
Russell Brown, Ph.D – Branch Chief, Ecosystems Surveys Program, NOAA
Incorporation of Advanced Technology to Meet the Expanding Data Requirements of Marine Spatial Planning

Eileen S. Kenney – Director of Permitting, Deepwater Wind LLC
Environmental Sampling to Satisfy Permitting

Albert J. Williams 3rd, Ph.D – Scientist Emeritus, Woods Hole Oceanographic Institution (WHOI)
The Coastal and Global Scale Nodes of the Ocean Observatories Initiative as Viewed by a Fan

Stephen Wolf – DAMOS Program Manager - U.S. Army Corps of Engineers
Technological Advances in Environmental Monitoring Systems Bring Efficiency to Monitoring Dredged Material Disposal Sites

1:30 – 3:00 pm **Panel: SNAME — Engaging with Ocean Instrument and Vehicle Developers to Assist with Emerging Offshore Design and Installation Challenges**

Session Chair: Donald MacPherson, Chair, New England Chapter of Society of Naval Architects and Marine Engineers

Speakers:
William Simpson, PhD. – Professor, US Coast Guard Academy; C. Clifford Ness – Manta Research Corp.
Innovative Pressure Hull Design

Donald MacPherson – HydroComp, Inc.
Contemporary Thruster Design for Submersibles

Ray Fischer – Noise Control Engineering, Inc.
Keeping Vehicles Quiet

Wednesday, May 18

10:30 am – Noon **Panel: Future Defense and Maritime Security Initiatives**

Session Co-Chairs: David Mugridge – Fellow, Dalhousie University & Ric Walker – Maritime Safety & Security Specialist, Molchan Marine Sciences

Speakers:
Ric Walker – Molchan Marine Sciences, Inc.
Topic: Technology Demonstration and Evaluation: Setting the Stage for Future Initiatives?

Warren Heerlein – US Coast Guard R&D Center
Topic: Measuring the Deterrent Value of Maritime Counter Terrorism Activities

Michael Grzechowiak – Rite-Solutions, Inc.
Topic: Scalable Maritime Command & Control Architecture

Peter Johnston – Lansdowne Technolgies, Inc.
Topic: Critical Infrastructure and the Vulnerability of Ports

1:00 – 3:30 pm **Panel: Hydrographic and Bathymetric Measurement Technology Advancements**

Session Co-Chairs:
Capt. Andy Armstrong – Director, NOAA Center for Coastal Ocean Mapping at UNH &
Steve Withrow – Managing Partner, Trinity International Consultants, Inc.

Speakers:
Rebecca Quintal – SAIC, Newport, RI
Topic: Automated Contact Detection of Features on Sidescan Sonar Data for Seafloor Mapping

Lindsay Gee – IVS-3D, Inc.
Topic: Mid-water Software Tools for Processing and Analysis of the Latest Generation Multibeam Sonars

Rick Morton – Kongsberg Hydroid
Topic: The Increasing Use of AUV's for Hydrographic Survey

3:30 - 5:00 pm **Panel: Underwater Technology Challenges for Maritime Salvage and Recovery**

Session Chair: Capt. Jack Ringelberg, (USN, Ret.) – President, JMS Naval Architects, Inc.

Speakers:
Chuck Maclin – Phoenix International, Inc.
Deep Ocean Recovery

David Usher – Marine Pollution Control Corp.
Deep Oil Recovery

William Key – WK Tech Group
Application of Sonar in Salvage Operations

Michael Dean – Deputy SUPSALV, Director of Ocean Engineering (SEA00CB)
Remote Heavy Lifting Technology

John Flory – Tension Tech, Inc.
Rope Technology

Thursday, May 19

10:30 am – Noon **Panel: Emerging Requirements for Application of Underwater Vehicles and Robotics for Ocean Exploration**

Session Co-Chairs: Dwight Coleman, PhD. – Director, Inner Space Center, University of Rhode Island
Christopher Roman, PhD. – Asst. Professor of Oceanography, URI Graduate School of Oceanography

Speakers:
James Kinsey, PhD. – Woods Hole Oceanographic Institute (WHOI)
From the Challenger Deep to the Gulf of Mexico: Recent Operations with the Sentry AUV and the Nereus Hybrid Remotely Operated Vehicle

Alfred Hanson, PhD. – URI Graduate School of Oceanography
Emerging Requirements and Applications for Chemical Sensing Payloads on Autonomous Underwater Vehicles

Edison Hudson – iRobot, Inc.
The Role of Man-Portable, Low Logistics AUV's in Future Navy Operations

John Westwood, chairman of Douglas-Westwood, giving his presentation at the OceanTech Expo in 2010

New Techologies Debut at OB '11

Manufacturers often use the halls of the trade exhibition to announce new products and services, and Ocean Business 2011 in Southampton, UK was certainly no exception. Following is a sampling of the new technologies discussed during a busy three days at Ocean Business 2011.

Bluefin Robotics announced a contract to develop a robotic ship hull mine and Improvised Explosive Device (IED) identification and neutralization capability for use in Joint Service Explosive Ordnance Disposal. A manipulator arm will be integrated onto the HAUV, a hovering AUV designed specifically for ship hull inspection. HAUN-N is the name of the new variant of the HAUV. The current practice for hull mine/IED identification and neutralization involves sending divers to scan the hull for targets and, when found, to mark them and neutralize them manually. The Bluefin Team—consisting of Bluefin Robotics, Oak Ridge National Laboratory and Orca Maritime—proposes to accomplish the task with an HAUV-N equipped with a high-precision manipulator arm and a video camera. The AUV will be capable of maintaining station at the target while a remote operator neutralizes the device, thereby keeping divers out of harm's way and completing the task more expeditiously.

Teledyne RD Instruments unveiled its next-generation Acoustic Doppler Current Profiling (ADCP) product line at Ocean Business 2011. After 15, Teledyne RDI's Workhorse ADCP products will now be complimented by the new Sentinel V ADCP, the first in a series of V ADCP products based on a new technology platform. This self-contained instrument is available in three profiling ranges - 20m, 50m, and 100m. The Sentinel V ADCP boasts a litany of new features, including: multi-user access, allowing for two distinct sampling schemes from the same instrument; an integrated fifth beam for enhanced turbulence and waves measurement capabilities; high-speed wireless data download; and an off-the-shelf battery option. The new Sentinel V also includes a powerful, yet user-friendly software interface, aptly named Vector. Vector steps users through their system configuration using multiple views and touch-screen capability, and provides vast post-processing options for the display and interpretation of collected data.

iXBlue at OceanBusiness unveiled its new identity under the iXBlue Group, a group that brings together iXFiber, iXMotion, iXSea, iXSurvey, Resiconcept and Sodena. The company also announced that it has sold two GAPS pre-calibrated USBL systems and a PHINS 6000 inertial navigation system to Ashtead Technology, a leading equipment rental company focused on the offshore oil & gas, environmental monitoring and industrial inspection industries. GAPS (Global Acoustic Positioning System) is designed for high-accuracy tracking of ROVs, AUVs, divers and sonar or other towed systems. It can be used in a wide range of water depths, but performs particularly well in shallow, acoustically noisy waters. The units have their own internal inertial navigation system, which is pre-calibrated with the USBL before delivery to clients. This removes the need for a USBL calibration every time the system is mobilized.

Seatooth-lite is a compact, low power, radio modem from **WFS Technologies**. Seatooth-lite uses the latest digital technology to enable wireless radio communications and

Bluefin's Michael Donovan and **Deanna Talbot** ensured Ocean Business attendees were well aware of the Bluefin AUV's prowess. Bluefin recently announced that it was awarded a contract to develop a robotic ship hull mine and Improvised Explosive Device (IED) identification and neutralization capability for use in Joint Service Explosive Ordnance Disposal, a system to be based on its proprietary HAUV, a hovering AUV designed specifically for ship hull inspection.

See Bluefin's In-Water Demo at OceanTech Expo'11 **www.oceantechexpo.com**

location over a short range through water and ground. Due to its compact size, ease of deployment and low cost, Seatooth-lite is ideally suited for radio frequency identification (RFID) process equipment, networks and wireless SCADA applications. It is available as a tag or a terminal, and it has a number of applications, including: RFID Tagging of Subsea Assets; Wireless Connectors /Subsea Connector back up; and Sensor data harvesting

Reson was called on by Calegeo for SeaBat installation support while mobilizing its geophysical survey vessel Kommandor Stuart. Calegeo put its trust in Reson which resulted in the purchase of a new SeaBat 8160. The system along with Reson Engineering Service staff were onsite within 24 hours after order confirmation. The 50kHz multibeam sonar unit was installed by divers and will enable Calegeo to perform high-speed surveys in shallow water areas and down to 3000m. Reson have recently invested heavily in Engineering Services and increased Production capability in order to react quickly to client requests while providing a level of support which is second to none.

RBR unveiled he RBRduo, which is designed to offer more flexibility with the deployment schedule and measurement parameters while maintaining the RBR 24 bit sample resolution for high accuracy data. The unit features: More than 30 million measurements; More than 5-year deployment @ 1 min sampling interval; True USB 2.0 download speed; and Compatible with the MLM-1000 inductive mooring line modem. As As RBR president Greg Johnson, PhD, explained, "the data is more important than the instrument," and the RBRduo is arranged to allow scientists to retrieve and upload date quickly and easily while in the field via their iPhone.

ROMOR Ocean Solutions, Canada released a new version of its C-ROM Mooring Solution, the C-ROM Plus. The C-ROM Plus builds on the flotation technology created within the 80 lbs flotation C-ROM package, to offer an increased 105 lbs buoyancy solution for enhanced instrumentation payload capabilities. All this is created with only a minor change to the standard design, adding only two inches in length. ROMOR's SeaRecovery Anchor Retrieval RotoDrum can also be included with this upgraded model for anchor recovery up to depths of 500m. Both the C-ROM and C-ROM Plus models now also have the capability of going to full ocean depths with just a slight change to the buoyancy within. For more information, please visit the ROMOR and

Teledyne RD Instruments unveiled its next-generation Acoustic Doppler Current Profiling (ADCP) – the new Sentinel V ADCP (pictured above) – product line at Ocean Business 2011. Being in the UK, the Teledyne RDI team had the assistance of an authentic Town Crier (pictured below) to help spread the word.

iXBlue's GAPS (Global Acoustic Positioning System) is designed for high-accuracy tracking of ROVs, AUVs, divers and sonar or other towed systems.

As **RBR president Greg Johnson, PhD,** explained, the RBRduo offers more flexibility with the deployment schedule and measurement parameters while maintaining the RBR 24 bit sample resolution for high accuracy data.

Planet Ocean booths.

Rockland Scientific unveiled the microRider-1000-6, a small instrument package for turbulence microstructure measurements, designed to integrate with a variety of instrument carriers, such as Ocean Gliders, AUV, ROV, CTD rosettes, and profiling floats. microRider-1000-6 features include: Internal Data Recording; 1000 m pressure rating; Up to five turbulence sensors; 2x SPM-38-1 microstructure turbulence shear probes; 2x FP07-38-1 microstructure fast thermistors; and more.

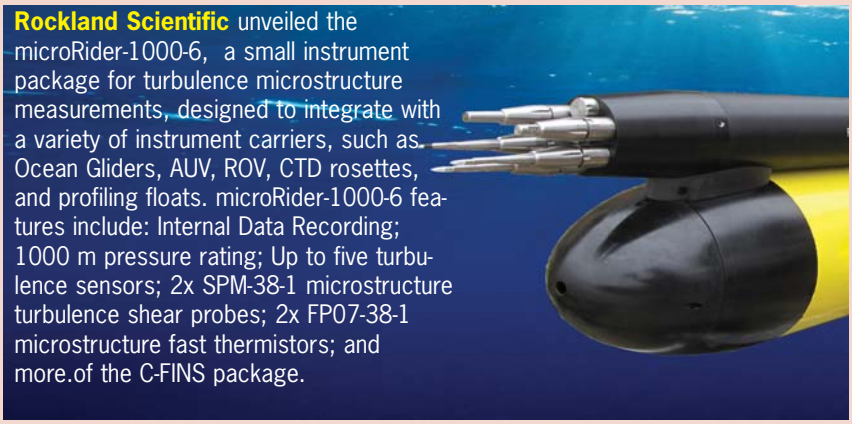
BlueView Technologies demonstrated its P900-130 2D Imaging Sonar and the BV5000 3D Mechanical Scanner dockside at Ocean Business. The live, in-water demonstration showcased the capabilities of both systems, and enable attendees to see the data and image quality that BlueView has become known for.

Turner Designs introduced C-FINS (Fluorometric Integrated Nautical Mapping System), integrating the C3 Submersible Fluorometer's digital output with GPS data for data mapping. A simple software module enables C-FINS and ArcGIS to work together allowing for real-time mapping of fluorescence, temperature, depth, and turbidity. The ability to capture and integrate these data reliably using the C-FINS package is an enhancement to its C3 product line.

After 15 years of success (and nearly 13,000 Workhorse products delivered worldwide), the next generation of Teledyne RDI ADCP products has arrived. Teledyne RDI announced the roll out of its new Sentinel V Acoustic Doppler Current Profiling (ADCP) – the first in series of next generation ADCP products.

Kongsberg Maritime launched its most advanced underwater digital stills camera at the Ocean Business. The OE14-408 is the latest underwater digital stills camera to be revealed in Kongsberg Maritime's portfolio of underwater and harsh environment cameras and imaging systems. The OE14-408 is designed to provide superb image and color quality and has a range of newly enhanced features since the previous OE14-208 model. These include 10 mega pixels per image (double the pixel resolution), improved color depth and dynamic range, Ethernet upload connectivity, a much faster flashgun refresh rate and a more compact housing for ease of deployment. When used in conjunction with Kongsberg Maritime's new dedicated flashgun (The OE11-442), the camera offers accurate exposure control via through-the-lens (TTL) flash metering resulting in striking image clarity. The flashgun recharge rate has been doubled, allowing improved productivity for inspection operations. The OE14-408 has a 5 x zoom capability and is depth rated from 4500m to 9000m. Each image is framed and temporarily stored on the inbuilt 8GB Solid-State Storage. The images can be the uploaded 'on the fly' via USB2 or Ethernet, meaning that they can be transmitted immediately to the surface or to shore – and viewed anywhere on the globe, therefore increasing operational efficiency of ROV or lander deployment.

CARIS released Bathy DataBASE 3.1, a move which the company claims continues to solve the demands for robust and scaleable data management for the storage and analysis of ever-expanding volumes of sonar and LiDAR data. Bathy DataBASE now works with Oracle Spatial 11g utilizing the GeoRaster and geo point cloud data structures for storage. Oracle Spatial has been specifically designed to meet the needs of advanced geographic information system applications. This latest release of Bathy DataBASE expands the database system options available to clients following last year's release of Bathy DataBASE 3.0, which offered the open source



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BlueView Technologies demonstrated its P900-130 2D Imaging Sonar and the BV5000 3D Mechanical Scanner dockside at OB 11.

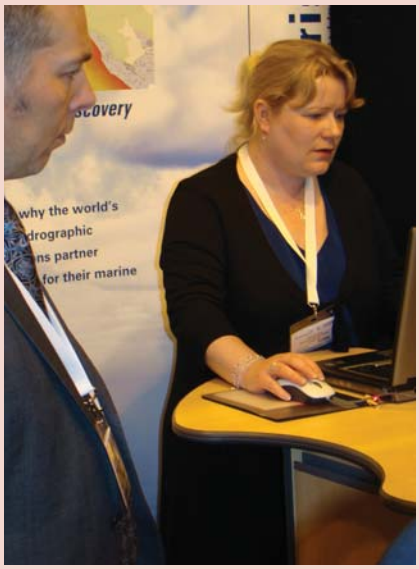
PostgreSQL database for backend storage. The PostgreSQL database option continues to be supported in the 3.1 release.

Chelsea Technologies announced a contract with Hamworthy Krystallon to supply robust sensor systems to monitor their exhaust gas cleaning system as part of the Messina ship-building program. "This is a natural extension to our business supplying FerryBox environmental systems for commercial vessels and ships of opportunity," said Richard Burt, Chelsea's marketing director.

BioSonics Inc. had a significant presence at Ocean Business, with new products on display including the DT-X SUB, a submersible autonomous echosounder. BioSonics will also present information about their new MX Series echosounders, a lower priced single-beam system with specialized data acquisition and visualization software for aquatic habitat assessment. BioSonics offered a demonstration aboard RV Callista, providing visitors the opportunity to see the DT-X echosounder in action and check out Visual Acquisition 6, BioSonics latest data collection software. BioSonics also hosted a training meeting for authorized distributors on Thursday, April 7 at 1300h.

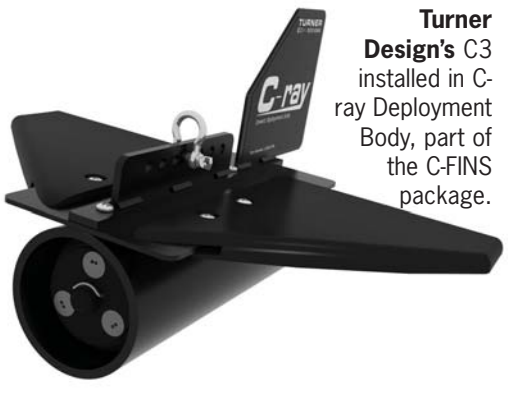
Instrument Concepts launched its latest new product in family of acoustic sensing devices – icLISTEN LF with Ethernet, at Ocean Business. "With the addition of the Ethernet link, the icLISTEN LF becomes the world's first smart hydrophone with a universal high speed link, enabling a wider range of users to listen in the ocean using their existing PC's & networks," said Mark Wood, President of Instrument Concepts. The Ethernet leverages the flexibility of networks/internet allowing the user to listen in the ocean right next to the instrument, or from the other side of the world. Multiple users can access the instrument at once. This standard interface provides built-in isolation, fast data, and lets the user configure icLISTEN LF using a browser. Users of icLISTEN LF can create large hydrophone arrays using a new Ethernet standard, the IEEE 1588 Precision Timing Protocol. This protocol synchronizes the instruments to within 2 usec, putting all recorded data on a common time reference. Up to 32GB of storage is available as well, with this instrument, along with configurable acoustic signal processing and ultra low power (125 MW). This instrument is ideally suited for seismic signal band listening.

Just prior to the show, **OceanServer** received a fourth contract from the University of Michigan for an Iver2



Andy Hoggarth, left, marketing and sales manager, **CARIS**, watches the demonstration of his company's new Bathy DataBASE 3.1

Chelsea Technologies demonstrated its Fast Repetition Rate Fluorimeters onboard RV Callista at Ocean Business 2011.



Turner Design's C3 installed in C-ray Deployment Body, part of the C-FINS package.

EP42 equipped with Side Scan Sonar, 10 beam DVL and ADCP. Early this year, OceanServer delivered the University's third vehicle for service in the Great Lakes. The new vehicle will be used as part of the Great Lakes Observing System Tributary Monitoring project with funding from the Great Lakes Restoration Initiative. The project looks at monitoring five separate Areas of Concern across all five Great Lakes, using different monitoring methods. The University of Michigan's part of the project will be using the Iver2 AUV for surveying Saginaw Bay, an Area of Concern in Lake Huron. Researchers will use a Bottom Classification Software with the sonar to support an on-going study of Cladophora growth that leads to unsightly and foul smelling muck on the beaches. The new Iver vehicle will also be used for mapping fish habitats and reefs.

L-3 Klein's new UUV-3500 product line leverages a powerful wholly FPGA implemented - multi-channel processing engine. The sonar engine simultaneously optimizes two different - and concurrent - output data streams for: photo quality side scan imagery and high accuracy, co-registered swath bathymetry. The UUV-3500 operates exclusively with L-3 Klein's proprietary wideband technology providing quality scan range and resolution in a low power, compact and lightweight payload. The swath bathymetry option allows for wide swath performance which is typically 10-12 times the overall altitude of the UUV and thereby significantly greater coverage than can be achieved by a multi-beam echo-sounder.

A new addition to the **Teledyne TSS** range of DMS motion sensors was launched at Ocean Business. The DMS-500 range is being developed specifically to meet the needs of users who require a top-quality motion sensor with Ethernet connectivity, but do not require the subsea-rated housings that typify Teledyne TSS products. The result will be a complete range of conservatively-priced sensors that incorporate a number of advanced and innovative features for applications such as Dynamic Positioning (DP), wave height monitoring and structural stress monitoring. The versatile design means that the range will be available in various accuracies to make it suitable for a wide range of bespoke applications. The first phase of the product's launch introduces the Roll Pitch range of sensors including the DMS-525RP and the DMS-535RP and DMS-550RP, which were on view at Ocean Business. These are designed to provide a reliable, accurate and cost-effective choice for motion measurement with roll/pitch accuracies from 0.25° to 0.50° RMS with high dynamic accuracy during vessel turns. Unique features of the new sensor are the ability to provide power and data over Ethernet; and the inclusion of two independently configurable serial outputs - offering users a wide range of connection and application options.

PDM Neptec launched two new products at Ocean Business 2011. The low loss Omicron Subsea Fiber Optic Connector is high on performance, yet low on cost. Rated for use to 5000 meters (mated), and designed for compact installations requiring minimum connector size, Omicron incorporates proven ferrule carrier and alignment technology, producing insertion loss performance of <0.5 decibels at typical operational wavelengths with single or multimode fibers. The Compact Quickcure Molding System (QMS) is a single slot, portable hotplate system for quick and easy cable splicing and repairs offsite. It comprises a single slot custom made mould heating block, Quickcure heater and temperature probe. Sachet based twin pack Elastomers are available for use in custom made moulds which are supplied with a Peg Spanner and Mould Drift for de-molding. The Compact QMS heats up to the required tem-

Callum A. Magee, Business Development Manager, AC-CESS, next to the company's unique AC-ROV system in a test tank at Ocean Business 2011. In addition, the company displayed a working mock-up of a miniature inspection vehicle able to traverse most any sized pipe.

perature in 10 minutes, achieving uniform heat distribution within the mould, which is an essential factor in producing repeatable quality mouldings. It is suitable for cable installations up to 12mm in diameter which are awkward or costly to remove for repair and maintenance.

Oceanscience debuted the Underway SV, designed to allow sound velocity profiling from a moving vessel. The Oceanscience underway SV offrs vertical sound velocity profiles in minutes, with having to stop the survey vessel. The latest Valeport digital sound velocity measurement technology is combined with the Oceanscience underway sensor deployment to generate a new tool for hydrographic surveying.

Satlantic performed a live instrument demonstrations of its new in situ FIRe active fluorometer system onboard the RV Callista, which included an overview of the FIRe technology, logging and real-time display of field measurements as well as a review of the new FIReCom software.

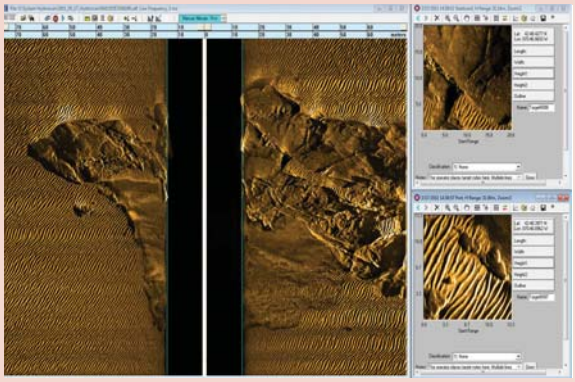
Applanix announced at Ocean Business the release of POS MV V5 (Position and Orientation System for Marine Vessels), the next generation of its industry leading georeferencing and motion compensation system for hydrographic surveying. The system is available in three performance levels—POS MV WaveMaster, POS MV 320 and POS MV Elite—to produce an optimal solution for a variety of vessels and conditions. Version 5 provides the robust and reliable positioning and orientation information for which Applanix products are known, even in the most difficult environments for hydrographic survey applications. The latest version expands the performance of POS MV with a number of key new features including: "With the introduction of POS MV V5, we have further expanded the limits of the operating environments in which Applanix technology can excel," commented Peter Stewart, Product Manager at Applanix. "Whether you operate in a busy port, or in the most remote offshore areas, the new features of POS MV V5 ensure we continue to provide the most accurate, reliable and robust position and orientation solution for hydrographic survey applications."

ORE Offshore launched a new product at Ocean Business; the SPORT acoustic release brings the reliability and easy-to-use features of the standard Push Off Release Transponder (PORT) and puts it into a light-weight easy-to-handle package. The new Shallow water Push Off Release Transponder

Oceanscience debuted the Underway SV, designed to allow sound velocity profiling from a moving vessel.

PDM Neptec's Gary Kelly and **Susie Culhane** reported brisk traffic at OB '11. PDM Neptec launched two new products, including the low loss Omicron Subsea Fiber Optic Connector

Teledyne TSS range of DMS motion sensors was launched at Ocean Business.



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(SPORT), for shallow water and small boat deployments, comes in a variety of configurations. The pop-up configuration is an all-in-one design with flotation, acoustic ranging, acoustic tilt information and release functions all built in to a one-person deployable unit. The SPORT can also be used in a standard in-line mooring or it can be laid on its side to easily fit into a trawl resistant bottom mount. With its light-weight housing and corrosion resistant Ultem push-off link, it can withstand the harshest shallow water environs.

The MacArtney Underwater Technology Group conducted diver demonstrations of underwater cameras and live comparison of sonar technologies at Ocean Business, with presentations in the test tank, at dockside, in the classroom and on the exhibition stand. At the "Lights, camera, action!" session in the test tank, divers will be demonstrating the MacArtney LUXUS P1 video unit live. Dockside, a "What's below?" demonstration featured a Kongsberg Mesotech scanning sonar and a DIDSON sonar working side by side to perform a recovery procedure. In the classroom MacArtney presented a first-hand account of real life experiences using the MacArtney TRIAXUS high speed undulating ROTV.

Contros offers its HydroC CO2 Carbondioxide Sensor, used for enhanced oil recovery (EOR) or stored in depleted oil and gas fields in Carbon Capture and Storage projects (CCS) requires zero tolerance for leakage emphasizing the need for precise Measurement, Monitoring & Verification (MMV). Injection facilities, such as trees and wellheads can emit CO2, while at the same time large amounts of dissolved gas could be transported from the deep strata towards the seafloor due to injection-mediated overpressure or density driven uplift. CO2-rich leakage quickly diffuses in water, which acidifies the seawater and affects the environment. CO2 leak detection methodology is site-specific and depends on various environmental parameters and monitoring goals. A direct way to detect even "invisible" CO2 leakage at the injection facilities or at the surrounding seafloor is the CONTROS' HydroC CO2 Sniffer

Knudsen Engineering used Ocean Business as the platform to launch PINGER its new Sub-Bottom Profiling Package. The PINGER SBP features a large aperture receiver that provides higher directivity while remaining lightweight. Another advantge of the PINGER SBP receive array is its wide bandwidth. The same receive array can be used (simultaneously) for multiple frequencies.

Teledyne Benthos unveiled its new generation of acoustic telemetry modems. The new ATM-900 series modems add features and functionality that meet industry needs based on the company's proven acoustic technology. The modems are designed to incorporate enhanced data logger capability up to 6MB in a flash file format and offer dual serial ports, allowing users to connect to 2 sensors with a single modem. The new modems are available in 3 configurable formats, with others soon to follow.

For more information on the companies in this report:

Applanix	www.applanix.com
BioSonics	www.biosonicsinc.com
Bluefin	www.bluefinrobotics.com
Blueview	www.blueview.com
CARIS	www.caris.com
Chelsea Technologies	www.chelsea.co.uk
Contros	www.contros.eu
Instrument Concepts	www.instrumentconcepts.com
iXBlue	www.ixblue.com
Knudsen	www.knudsenengineering.com
Kongsberg	www.km.kongsberg.com/cameras
L-3 Klein	www.kleinsonar.com
MacArtney	www.macartney.com
Oceanscience	www.oceanscience.com
OceanServer	www.ocean-server.com
ORE Offshore	www.edgetech.com/ore-offshore
PDM Neptec	www.pdmneptec.com
RBR	www.rbr-global.com
Reson	www.reson.com
Rockland Scientific	www.rocklandscientific.com
ROMOR	www.romoroceansolutions.com
Satlantic	www.satlantic.com
Teledyne Benthos	www.benthos.com
Teledyne RDI	http://www.rdinstruments.com/followV.aspx
Teledyne TSS	www.teledyne-tss.com
Turner Designs	www.turnerdesigns.com
WFS Technologies	www.wfs-tech.com

Kelly Joins Teledyne RDI

Teledyne RD Instruments (RDI) announced that Alan Kenny has joined Teledyne RD Instruments as the new Sales Manager for the company's navigation product line. Prior to this appointment, Alan served as Vice-President of Sales for the Americas for RESON. He brings with him a 27-year career in acoustics, vibration, and mechanical and fluid dynamics, with an educational background at the United States Naval Academy and the University of Minnesota.

Harrison to Lead Teledyne Geophysical Instruments

Teledyne appointed Scott Harrison as vice president and general manager of its Teledyne Geophysical Instruments business unit. Teledyne Geophysical Instruments designs and manufactures terrestrial seismic exploration products from its facilities in Houston and Stafford, Texas; Mitcheldean, United Kingdom; and Singapore.

Harrison received his Bachelor of Science degree from the United States Naval Academy in Annapolis, Maryland and has attended executive management programs at Stanford University and the London School of Business. Following graduation from the Naval Academy, he served as a nuclear submarine warfare officer.

Horizon Welcomes Oceanographer

Horizon Marine announced the arrival of a new hire in the Marion office and the promotion of Neha Sharma to Eddy Watch Operations Manager. Benjamin Shaw, M.S., a graduate of the University of Miami's Rosenstiel School of Marine & Atmospheric Science, has joined Horizon Marine as Physical Oceanographer, Eddy Watch Analyst. His duties will include analyzing data and preparing Eddy Watch reports on the location and strength of ocean currents in the Gulf of Mexico and offshore Trinidad and Brazil. Ben will also be a Pilot in Charge (PIC) of Horizon Marine's AUV fleet.

BlueView Hires Lesnikowski

BlueView Technologies added Nick Lesnikowski as 3D Product Manager/ACSM Hydrographer. Lesnikowski will direct and manage BlueView's 3D Mechanical Scanning and MicroBathymetry product lines, and will provide technical support for hydrographic survey applications. After receiving a degree in Geology from the University of Massachusetts in 1982, Lesnikowski worked as a geophysicist for Amoco Production Company in New Orleans interpreting seismic data on projects in the Gulf of Mexico. As an ACSM certified hydrographer, Lesnikowski brings an impressive skill set and experience level to BlueView.

Global Diving & Salvage Hires Cargol

Global Diving and Salvage hired Mike Cargol as general manager for its Gulf of Mexico region, based in Houston, TX. Cargol joins the company with a diverse resume from the oilfield and offshore sectors. His experience in all facets of the service market makes him the ideal choice to lead Global's Gulf Coast growth initiatives. Cargol was previously employed by Houston based Wild Well Control, Inc.

Marport Names Chapman Chief Sonar Engineer

Marport Deep Sea Technologies named Sean Chapman as Chief Sonar Engineer. Chapman has nearly 20 years of technical leadership in the design and development of Synthetic Aperture Sonar for commercial and military programs. Chapman will ensure that Marport's new imaging sonar solutions are designed and built on sound physics and engineering principles, while paying close attention to management of technical risks. Chapman joins Marport from Ultra Electronics, where he was Chief Scientist for Sonar Systems. He received his First Class honours B.Sc. in Pure and Applied Physics with Electronics from Nottingham University, UK. He will be based in Weymouth, UK.

Subsea 7 Adds New Schilling ROVs

Schilling Robotics was awarded new contracts for ROV systems from Subsea 7. A total of three new ROV systems will be supplied for delivery in Q2 2011, including one (1) 150hp, 3,000m rated ACV ROV system and two (2) 150hp, 3,000m rated HD ROV systems. The ACV ROV system is an addition to Subsea 7's existing fleet of construction vehicles and will be mobilized on Subsea 7's new pipelay/heavy lift vessel, the Seven Borealis. The HD ROV system is a work-class vehicle which provides flexibility for construction and

inspection, maintenance, and repair (IMR) applications. The HD's integrated system design leverages modular sub-systems for ease of maintenance, and provides the most onboard space available in a mid-size vehicle for integrating specialized intervention tooling.

GOSL Takes Delivery of Sub-Atlantic Mohawk Integrated with SeeTrack CoPilot

SeeByte has successfully integrated and delivered SeeTrack CoPilot with the Sub-Atlantic Mohawk to Geodetic Offshore Services Limited (GOSL). GOSL recently purchased the Mohawk Inspection Class ROV to offer offshore pipeline surveys, inspection surveys and tooling capabilities in order to support the growing needs of their clients. Realising the benefits of the solutions offered by SeeByte's SeeTrack CoPilot software, GOSL have purchased a SeeTrack licence to accompany the Mohawk. The system was demonstrated and accepted at the Sub-Atlantic test tank in Blackburn, Aberdeenshire on Tuesday 12th April.

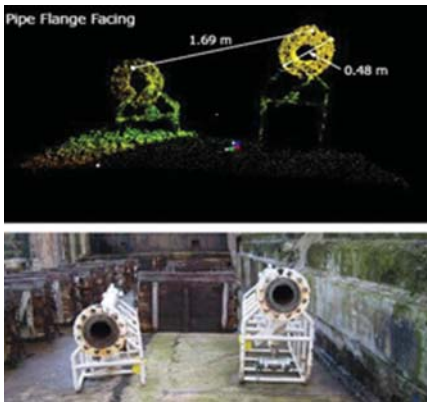
"I was very pleased to see for myself how easy it was to control the ROV using SeeTrack" said Emanuel Ekpeyong CEO of GOSL, who had never piloted an ROV prior to this demo.

ADC MK 5 Subcontract Awarded to Bluefin

Bluefin Robotics won a subcontract from Ultra Electronics Ocean Systems, Inc., to support Ultra in the development, design, fabrication, integration, and testing of the acoustic device countermeasure (ADC) MK 5 with a particular responsibility of providing the mobility subsystem. The ADC will be an acoustic torpedo countermeasure with advanced features that can be employed either as a static or mobile device. It will replace the legacy MK 2 and MK 3 torpedo countermeasures and improve the defense of Navy submarines against acoustic homing torpedoes. The ADC MK 5 program marks an expansion of the Bluefin product line which currently includes five different AUV models. The Naval Sea Systems Command, Washington, D.C., is the contracting activity.

PROJECT: New Imaging Sonar System for Ultra-Deep O&G Ops

BlueView Technologies was awarded funding from RPSEA (Research Partnership to Secure Energy for America) and is partnered with Chevron's Energy Technology Company to test acoustic imaging and measurement systems that improve underwater metrology, accelerate installations, enhance inspection capability to ensure flow, and reduce downtime or shut-in with detailed structure assessments. BlueView will increase the fidelity of engineering information by providing detailed measurements, leak detection, and detection of degraded pipeline insulation in ultra-deepwater



The images above shows an underwater 3D scan captured with the BlueView BV5000 3D Mechanical Scanner.

(>15,000). The new inspection capabilities can improve operating efficiency, reduce time and costs, minimize reworks, and improve safety and environmental performance by providing data to enable proactive maintenance and repair activities.

BlueView Supports Rozalia Project

BlueView Technologies is supporting the Rozalia Project with its popular 2D Imaging Sonar. The Rozalia Project is a grass roots organization based in the north eastern U.S. and is dedicated to locating and removing marine debris, as well as working with groups to educate and inspire people on the effects of marine debris. The Rozalia Project uses state-of-the art underwater imaging technology, including BlueView 2D Imaging Sonar on a VideoRay ROV to hunt for marine debris on both the surface and the sea floor.

www.blueview.com

SJC System Consortium Contracts with SubCom, NEC

The global consortium of telecommunications companies formed to

build and operate the South-East Asia Japan Cable (SJC) system officially announced the start of the construction of the project that will link Brunei, China Mainland, Hong Kong, Philippines, Japan, and Singapore, with options to extend to Indonesia and Thailand. First announced in December 2009, the cable was initially planned to be 8,300 km in length, linking 5 countries/territories. SJC's length is now 8,900 km which could extend up to 10,700 km, linking up to 8 countries/territories while supporting an initial design capacity of over 15 terabits per second.

DEA: Two SeaBat 7125-SV2 to Support NOAA Charting Requirements

David Evans and Associates (DEA) Marine Services Division purchased two of the new SeaBat 7125-SV2 systems. DEA's clients include private industry, local and regional municipalities, port authorities, the U.S. Army Corps of Engineers and the National Oceanic and Atmospheric Administration (NOAA). DEA is a long-time customer of RESON and was an early adopter of the SeaBat 7125. The upgraded 7125-SV2 system provides dramatically improved performance.

SeaBat 7125

NOAA Announces New Members of The Hydrographic Services Review Panel

NOAA Administrator Jane Lubchenco recently appointed nine new members to the Hydrographic Services Review Panel, a federal advisory committee that gives NOAA independent advice for improving ocean and coastal navigation products, information, data and services. "Optimizing the benefits of navigation services and products is a priority for the agency," said Margaret Spring, chief of staff for NOAA and the agency's representative to the Committee on the Marine Transportation System (CMTS). "We look forward to hearing perspectives and receiving advice from our new committee members, who represent a wide variety of maritime and coastal zone stakeholder interests.

New members of the panel are:

- **Dr. Lawson W. Brigham**, University of Alaska Fairbanks, Geography Program
- **Stephen Carmel**, Maersk Line, Ltd.
- **Jeffrey Carothers**, Fugro Consultants, Inc.
- **Dr. Michele Dionne**, Wells National Estuarine Research Reserve
- **William Hanson**, Great Lakes Dredge & Dock Company, LLC
- **Dr. David A. Jay**, Portland State University, Department of Civil & Environmental Engineering
- **Joyce Miller**, University of Hawaii at Manoa, Joint Institute for Marine and Atmospheric Research
- **Scott R. Perkins**, Wilson & Company, Inc.
- **Susan Shingledecker**, BoatUS Foundation

The new members join current members:

- **Edmund Welch**, Passenger Vessel Association (panel chair)
- **Captain Sherri Hickman**, Houston Pilots
- **Captain Thomas Jacobsen**, Jacobsen Pilot Services, Inc.
- **Dr. Gary A. Jeffress**, Texas A&M University, Corpus Christi, Geographic Information Science
- **Ramon Torres Morales**, InterAmerican University, Puerto Rico
- **Matthew Wellslager**, South Carolina Geodetic Survey (reappointed)

The new panel members attended a navigation services orientation briefing on March 24-25, in Silver Spring, Md. NOAA's navigation services offices – the Office of Coast Survey, National Geodetic Survey, and the Center for Operational Oceanographic Products and Services – presented some of the national challenges the panel will explore in the months and years ahead.

The Hydrographic Services Review Panel was established in 2003 as directed by the Hydrographic Services Improvement Act of 2002. The panel functions in accordance with the Federal Advisory Committee Act and advises the NOAA administrator on matters related to NOAA's hydrographic and navigation services.

MMT and NetSurvey join Forces

MMT and NetSurvey have recently merged after six years cooperation on various hydrographic survey assignments. The goal is to benefit from synergy effects and to jointly provide high-resolution surveys. NetSurvey will bring strong technical capabilities in the field of multibeam expertise to the MMT Group, which recently acquired all shares in NetSurvey Limited, Banbury, UK. Both companies operate at the cutting edge of technology and deliver high-quality, client-focused products to the world's energy companies, hydrographic offices, environmental agencies and government departments.

Over the last decade MMT has conducted numerous survey assignments in UK waters and the recent merger will provide a continuous presence on the UK market. The office in Banbury will act as headquarters for MMT operations in the UK. Following the merger, the MMT Group will employ over 250 specialists in the field of marine survey, with employees both in the United Kingdom and Sweden. Bringing together MMT and NetSurvey provides a powerful platform for hydrographical surveys, pipeline inspections and marine infrastructure projects on the European and world-wide markets.

Teledyne TSS Tests MK31 in Submerged Ops

During recent trials with an unspecified Navy, Teledyne TSS reports that it has successfully demonstrated its MK31 Inertial Navigation System in a Naval Submarine application that required accurate free inertial performance during a submerged operation. "Teledyne TSS has over 130 years of combined pedigree in providing high performance navigational equipment in military surface vessels and we are delighted that our latest product, the MK31 Inertial Reference System, has now performed brilliantly in an extremely demanding submerged operation," said Brian Huntsman, Vice President/General Manager.

Birns Recieves ABS Certificate

BIRNS, Inc. received American Bureau of Shipping (ABS) Product Design Assessment (PDA) Certification for its popular lines of penetrators. This certification process included testing and review by the national organization, and resulted in ABS pre-approving all design, drawing and test procedures for BIRNS electrical penetrators and cable assemblies for underwater vehicles, systems and hyperbaric facilities for use on a variety of ABS-class vessels. BIRNS does all penetrator testing in-house, witnessed and certified by ABS officials, and provides inclusive ABS lead times and pricing for such orders. The stringent testing procedures include high-pressure helium leak detection to the inboard side with multiple cycles of high-pressure saltwater to the outboard side, dielectric withstanding voltage and insulation resistance testing.

SeeByte Adds to Mine Counter Measures Expertise

SeeByte welcomes Ltd. Commander Rob Cornick RN (retired) as a newly appointed Snr. Program Manager.

Cornick joins SeeByte having recently retired from the Royal Navy after 25 years as a Mine Warfare specialist. His last post saw Rob act as the Mine Warfare Program Officer at NATO's Undersea Research Centre, La Spezia, Italy. During his time there, Rob provided expertise, leadership and guidance researching, testing and shaping NATO's future Mine Countermeasures operating concepts and capabilities. His time spent with NATO forces and his own practical experience will be to the benefit of customers of SeeTrack Military.

MARINS Selected for Nuclear-Powered Sub

BAE Systems (Submarine Solutions) selected iXSea MARINS inertial navigation systems for HMS Audacious, the fourth boat in the UK Royal Navy's Astute-class, nuclear-powered attack submarine construction program. HMS Audacious will be equipped with two MARINS units. iXBlue will also supply a third unit for preliminary test work at BAE Systems' Astute Shore Integration Facility and provide engineering and project management support for the installation of the units onboard the submarine.

Log onto SeaDiscovery.com to explore these new job openings.

VIDEORAY ACCOUNT EXECUTIVE, GOVERNMENT & MILITARY

Job Location: USA, Washington, D.C., Philadelphia, San Diego, or Seat
About the Job:
VideoRay LLC, a global leader in underwater remotely operated vehicle technology, is seeking a motivated individual to fill the newly created position of "Account Executive, Government & Military."
Your primary objectives will be to develop new business and work with existing customers in the underwater Government and Military markets worldwide.
VideoRay is recognized worldwide as the leader in micro-sized Remotely Operated Vehicles for Port and Vessel Security. This new technology is gaining rapid acceptance and is being deployed worldwide to fight terrorism and provide force protection. VideoRay is seeking the right individual to lead and share in this initiative.
RESPONSIBILITIES:
Your duties will include, but not be limited to:
*New business prospecting and development, including phone calls; scheduling, preparing and conducting client meetings and demonstrations; and preparing presentations, proposals and bid specifications. Significant travel is expected.
*Existing customer retention and up selling strategies for the Government & Military markets.
*Attending training and associated workshops to increase product knowledge and to stay abreast of company products and pricing as well as to gain familiarity with competitor's products and pricing.
*Participating in trade shows, exhibits, open houses, and product demonstrations to promote company image and solutions.
*Sales tool creation for face to face sales presentations and indirect dealer and distributor sales.
EDUCATION:
A Bachelor's degree, preferably in a relevant technical discipline or related military or work experience is required.
A Master's degree in Marketing, Business Administration or a relevant technical discipline is a plus.
EXPERIENCE:
Five or more years business-to-business selling experience (military and/or marine industry is preferred, but not required) or military service in Navy or Coast Guard
Experience working with, and replying to, commercial and government RFP's and tenders
International sales experience
SKILLS:
A highly qualified candidate will have a thorough working knowledge of the Military and Government market including related business contacts. The ability to operate independently with minimal direct day-to-day guidance is critical. The candidate will be expected to target specific business development goals. The candidate will have an understanding of basic selling skills, with exceptional analytical, organizational, and communication abilities along with the ability to work within a professional, team-oriented environment. Additionally, the candidate will have superior knowledge of sales techniques including phone sales etiquette, networking, lead generation and the ability to capture and close business.

VideoRay offers a competitive compensation package that includes base salary, medical/dental, IRA and more. For more information on VideoRay LLC, please visit us online at www.videoray.com. At VideoRay LLC, "equal opportunity" is more than a line at the bottom of an ad. It's a commitment we put up front. EEO M/F/D/V.

VideoRay is looking to hire an Account Executive in one of the following locations: Washington, D.C., Philadelphia, San Diego, or Seattle.
No Recruiters or Agencies, please.
For immediate consideration, interested candidates should email resume and salary requirements, in MS Word format only. ONLY qualified candidates should apply.

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Nuclear Sub Stop in Southampton

During Ocean Business 2011 in Southampton, UK, Marine Technology Reporter was able to catch a relatively rare site, a British nuclear submarine surfaced. Details on the sub and its visit to Southampton were predictably scant.

(Photo: Greg Trauthwein)

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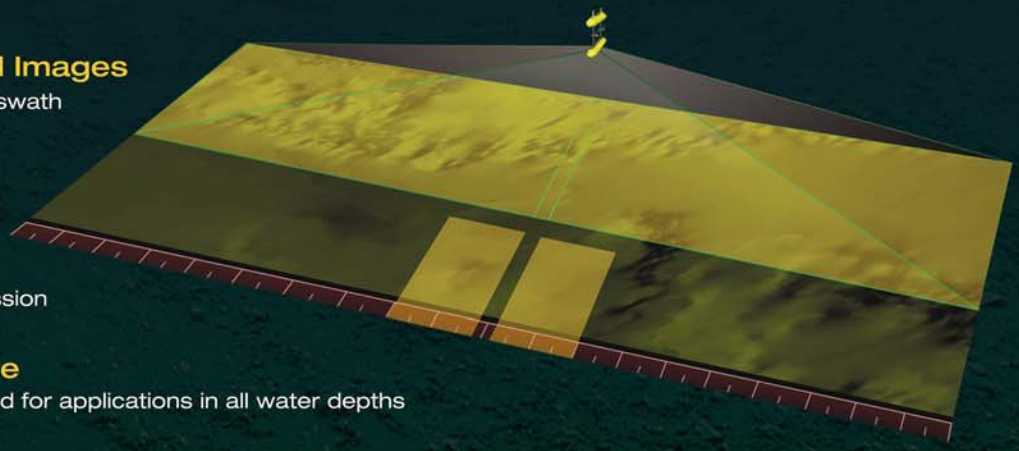

AquaPix® is the world's first software-centric Synthetic Aperture Sonar and sets a new benchmark for underwater imaging applications. Priced to compete with premium sidescan sonars, AquaPix® provides ultra-high resolution images and detailed 3D bathymetry of the seabed.

The broadband system utilizes Marport's award-winning Software Defined Sonar® architecture and can be dynamically tuned over a frequency range of 200 to 400 kHz. It uses the latest digital signal processing techniques to provide range-independent resolution of 2.5 cm x 2.5 cm over swath distances of up to 600 metres, delivering operational coverage rates 12 times greater than conventional sidescan sonar. This allows rapid and cost effective collection of large swaths of seabed imagery and 3D bathymetric data that meet IHO special order requirements.

AquaPix® imaging and mapping capabilities provide the critical level of detail required in demanding missions such as underwater ISR, mine countermeasures, hydrographic survey and seabed imaging. The modular and flexible system is designed for hull mount, AUV, ROTV or towfish configurations in all water depths.

A leader in acoustic imaging science, Marport develops and supplies Software Defined Sonar® solutions for a wide variety of commercial and military applications. For more information, visit www.marport.com or email us at aquapix@marport.com.

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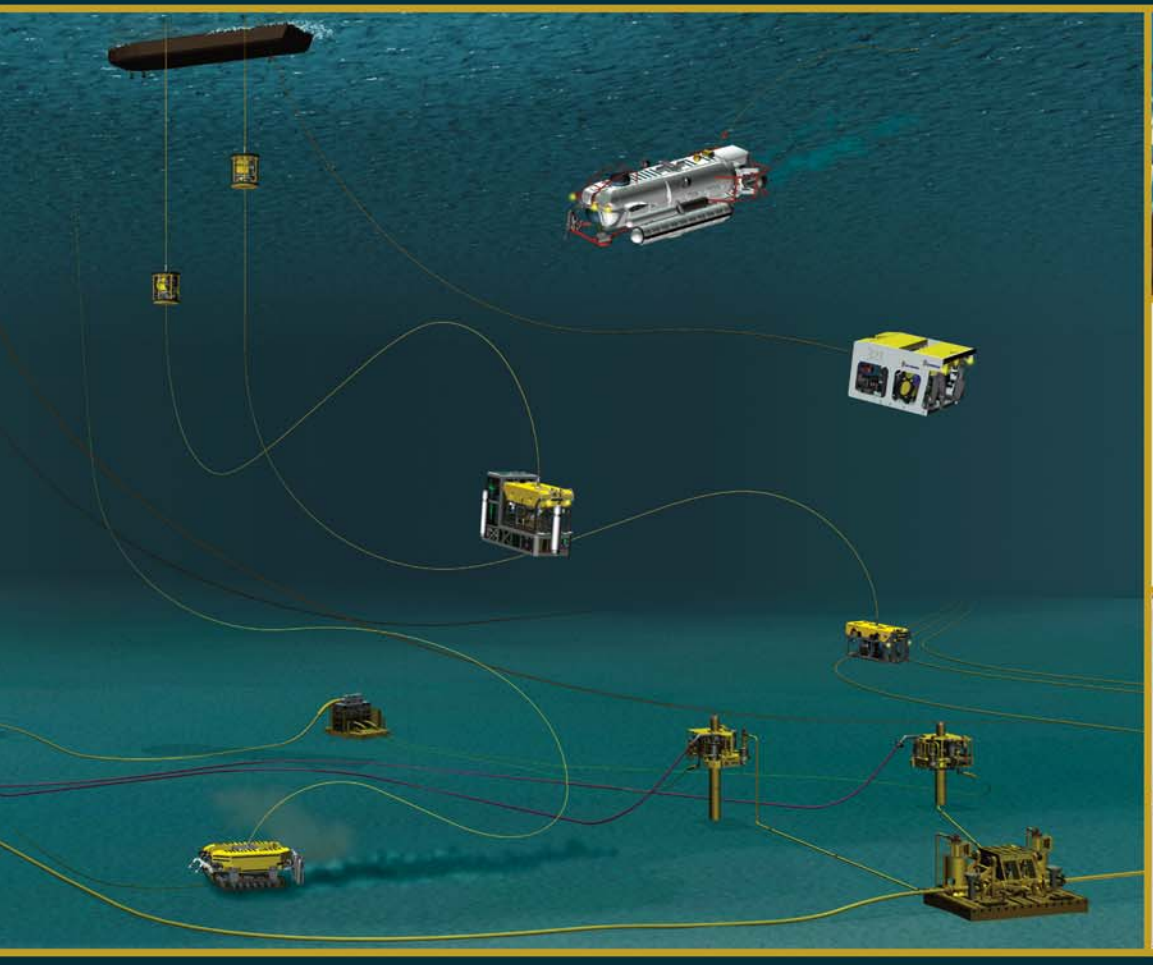

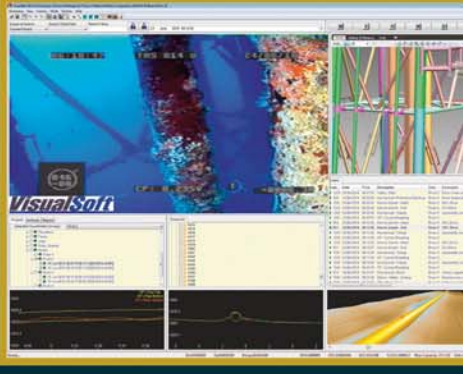

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