MARINE TECHNOLOGY REPORTER

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Ocean Observation

Extreme Sampling in the Hadal Trenches

Ocean Acidification
Long Range Projections

Subsea Construction
Injecting 45 Years of Life

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New threats, new methods

Renewable Energy
Riding the Waves & Tides


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Courtesy ASI

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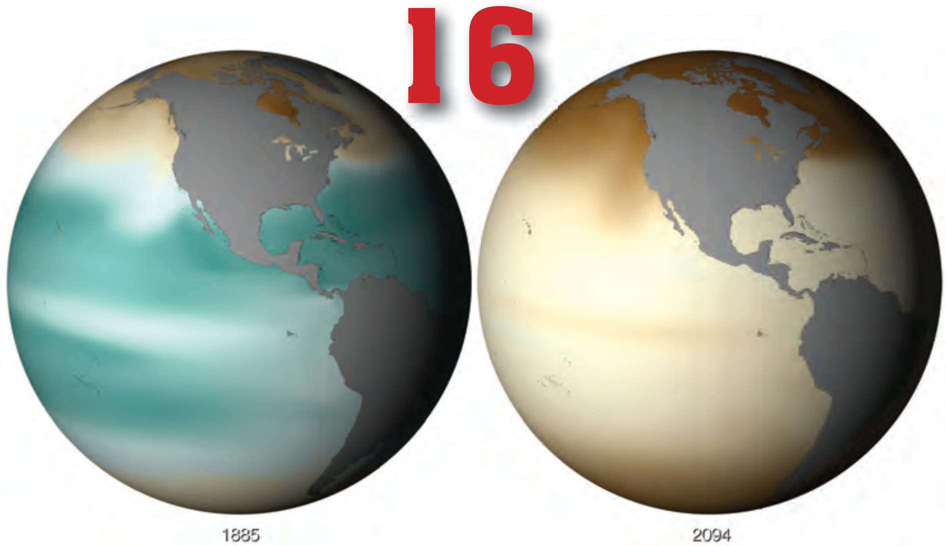

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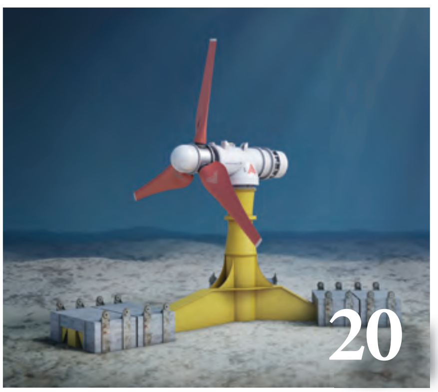
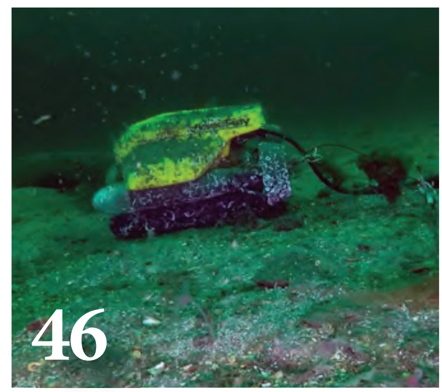
SUBSEA CONSTRUCTION
INJECTING 45 YEARS OF LIFE





The Authors

Marianne Molchan

Marianne Molchan is President of Molchan Marine Sciences (MMS) and a retired Navy Commander. MMS supports the development, evaluation and implementation of maritime safety and security technology systems for clients worldwide. Currently she serves as the Vice President of the Marine and Oceanographic Technology Network and is a Senior Advisor to Security Dynamics LLC. . *p. 24*

Angus Macaulay

Angus Macaulay is a Subsea Engineering Coordinator at Paradigm Flow Services. Angus has a mechanical engineering background and a Higher National Diploma. He moved from Subsea Project Engineer to his current role and has been integral in the development of key subsea technologies.. *p. 30*

Kira Coley

Kira Coley graduated with a BSc. (Hons) Marine Biology degree from University of Portsmouth and has extensive experience as a Field Scientist in various locations. *p. 32*

Photo ASI

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Problem Solved. In business, in life, these two words when said together deliver a sense of satisfaction and closure. The market that each and every one of you serve is nothing more than a series of problems that are faced on a daily basis. In subsea you have the pleasure to work in one of the most hostile, destructive places on the planet, making your job all the more vexing.

Maritime Surveillance and security not a new problem, and frankly it will never be 'solved.' Threats to national and personal security stem from many corners, from cyber space to the waterfront. This month I am grateful to welcome back to our pages a valued colleague, **Marianne Molchan**, who writes a feature starting on page 24 on *"Maritime Surveillance in the New Millennium."* From piracy to cyber attacks to port facility threats, Molchan discusses technique and technology designed to keep maritime assets safe.

Subsea Blockages are a significant problem faced by the oil and gas industry. As **Angus Macaulay** writes starting on page 30, the problem – which is rather common – can be so complex and costly to treat that some operators are known to leave multiple flow lines blocked for more than a decade. He details in his report how one North Sea operating company worked to clear flow lines – and cash flow lines – with non-intrusive technology.

Subsea Construction comes fraught with risk and challenge, particularly when upgrading or modifying an older installation. Starting on page 40 we discover how Boskalis, in close cooperation with Maersk Oil, embarked on a complex, multi-year subsea structural reinforcement campaign to take a subsea wellhead platform that was originally designed for 25 years of production and modify it so that it will produce for 70 years total.

Finally, it would not be a complete edition without contribution from **Kira Coley**, and per usual she tackles the toughest challenge. **Ocean Observation** and all that it entails is a ubiquitous part of all that you do, and this month she looks at *"Extreme Sampling: Hadal Trenches,"* starting on page 34, exploring how advances in underwater vehicles, image capturing and sampling are increasing opportunities for researchers to uncover the mysteries of the deep.

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Whorton

Photo: Teledyne Optech

Hamilton

Photo: Caris

Baldwin

Photo: Kongsberg

Whorton is the New President of Teledyne Optech

Dr. Mark Whorton has assumed the role of President of the U.S. organization Teledyne Optech, Inc. Dr. Whorton will oversee U.S. operations and apply his experience to the development of the Optech Coastal Zone Mapping and Imaging Lidar (CZMIL) and our line of digital aerial cameras.

Dr. Whorton has served Teledyne Brown Engineering (TBE) as Chief Technology Officer since October 2014 and previously as Director, Commercial Earth Imaging. He is the Principal Investigator for the Multiple User System for Earth Sensing (MUSES) instrument pointing system for the International Space Station (ISS) and led the origination of Teledyne's efforts in commercial Earth imaging. Dr. Whorton earned a Ph.D. in Aerospace Engineering from the Georgia Institute of Technology, and prior to joining Teledyne in 2009 he served as Chief of the Guidance, Navigation, and Mission Analysis Branch at the NASA Marshall Space Flight Center where he was a subject matter expert in dynamics and control of space systems. Dr. Whorton will continue his work on MUSES as CTO at TBE while he joins Teledyne Optech.

Hamilton Joins CARIS

Geospatial software developer CARIS announced that Travis Hamilton has joined its team as the product manager of the newest application in the CARIS software suite, CARIS Onboard. Hamilton has a bachelor's degree in Geomatics from the University of New Brunswick and is currently completing his master's degree. He has spent the last two years working in offshore survey as a data processor and operator of AUVs off the coast of Africa and other locations around the world. Hamilton is already familiar with the CARIS operation having recently worked under contract implementing a new Sound Velocity Correction algorithm for the HIPS and SIPS application.

Baldwin to Lead Seaglider Support Center

Kongsberg Maritime created a European support center in Southampton, U.K., for its Seaglider autonomous underwater vehicle (AUV), a support center to be led by Mark Baldwin. The new support center will begin stocking spare parts and battery refurbishment kits immediately and will have the capacity to perform standard vehicle battery refurbishment services and minor system repairs by Q4 2015. In addition to the new support center, Kongsberg Maritime will be adding a Seaglider vehicle to the pool of rental equipment maintained by the company's base in Aberdeen, U.K., allowing existing system users to expand Seaglider fleets and prospective customers to test ahead of purchase.

Tureaud, Miller Join Kraken

Kraken Sonar Inc. recruited two industry veterans to further develop its sensors-to-systems strategy. Joining the company is Dr. Tom Tureaud, who brings 30 years of industry experience with expertise that resulted in 12 patents, and Gina Miller, adding 10 years of unmanned underwater vehicle (UUV) system engineering and leadership to Kraken's design team. Dr. Tureaud comes to Kraken with underwater systems industry experience, having spent over 20 years at Vehicle Control Technologies Inc. in Reston, Va., where he managed the company's underwater platform group as chief engineer, overseeing mechanical, hydrodynamic and electrical design. He has been involved in the design of over 30 advanced underwater systems. These include: a patented towed docking system, a buoyant towed vehicle for specialized operations, an underwater

Slater & McLeay

Photo: Bibby HydroMap

Hailstones

(Photo: ASV)

Strahan

(Photo: WFS Technologies

search vehicle for unexploded ordnance, a towed sonar mine countermeasure detection system, an automated launch and recovery system and several UUVs. He has extensive industry publications and holds 12 patents. Prior to Vehicle Control Technologies, Tureaud served with Draper Laboratory and Allied Signal Corporation in a variety of design engineering positions. Tureaud holds a Ph.D. in mechanical engineering from the University of Notre Dame.

Bibby HydroMap Promotes Slater

Seabed survey company Bibby HydroMap has appointed Mick Slater as its new Operations Director. After three years with the company, Slater has been appointed to the role of Operations Director at Bibby HydroMap. With an MBE to his name and over 40 years of industry experience including more than 30 years in the Royal Navy, Slater will hold overall responsibility for HSE, IT, HR and Compliance.

Hailstones Joins ASV

ASV said that James Hailstones has joined its team as the company expands its reach into the offshore energy market. Based in Aberdeen, Hailstones will lead industry engagement as more firms look to introduce autonomous surface vehicles into their operations. Hailstones is an electronics engineer with more than 30 years experience in the offshore survey industry, operating in the oil and gas, government, communications and renewable sectors. After spending 15 years working in an offshore environment on a global basis, Hailstones moved into various managerial positions working both in the U.S. and U.K. over the last 15 years.

WFS Technologies Names Strahan VP

WFS Technology Ltd. appointed Bill Strahan as Vice President Operations and General Manager, WFS Technologies (NI). Strahan brings to the role more than 25 years' experience in manufacturing, logistics, engineering, strategic and quality systems roles. He has delivered site start-ups, set strategies and led major change projects in telecoms, IT, construction and process industries. Strahan has also developed individuals and teams to succeed both in periods of growth and cost reduction.

Tooms Joins WFS Board

WFS Technology appointed Paul Tooms to the company's advisory board. Tooms studied mechanical engineering at Imperial College, London. After a brief spell working in diesel engine manufacture he joined BP as a drilling engineer, clocking up 25 years across BP Upstream before being appointed to Head of Subsea Discipline in 2005. He took over as Head of Engineering for BP Upstream in 2009, and was made a Distinguished Advisor in 2012.

UTEC Survey, Teledyne Gavia Improve AUV Capabilities

UTEC, an Acteon company, announced a step forward for its growing fleet of Autonomous Underwater Vehicles (AUVs) following a series of field trials in conjunction with Teledyne Gavia. Partnering with Teledyne Gavia in San Diego, the company completed operational testing of features designed to optimize AUVs for commercial survey applications. UTEC Survey has been using the Gavia AUVs for a variety of projects around the world since 2010 and, since

(Photo: UTEC)

becoming part of the Acteon group of companies, they have become the single largest commercial user of the system with seven AUVs in the fleet. The recent San Diego trials focused on operations as deep as 1,000 meters with the AUV taking 25 minutes to travel from the surface to its survey depth. Features trialed included a new detachable float nosecone and Pneumatic Line Thrower (PLT) allowing the AUV to be safely retrieved at greater stand-off distances, a redesigned Teledyne Band-C acoustic modem transducer for improved seabed communication, a Side Scan Sonar system from Edgetech and L-3 Klein Associates with greater ranges and enhanced position capabilities including deep water real-time navigation solutions using Long Base Line (LBL) bottom nodes.

(Photo: Port of Rotterdam Authority)

Port of Rotterdam Installs New Buoys, Dolphins

Work toward the expansion and replacement of buoy berths and dolphin configurations in the Port of Rotterdam's Caland Canal and the Botlek is underway, with a targeted operational time of autumn 2015, the Port of Rotterdam Authority said. The buoys and dolphins reinforce the existing clusters in both liquid and dry bulk and are being used more and more, according to the port authority. In the first half of 2015, transhipment at buoys and dolphins rose by 21 percent from 8.3 million metric tons to 10.1 million metric tons compared to the same period last year. The increase was related mainly to the transhipment of fuel oil.

The positioning of dolphin configurations and the replacement of buoy berths with dolphins is in line with the port authority's ambitions to modernize the existing port area and to use it as intensively as possible. Larger vessels can moor at the dolphin configurations. The replacement of buoys with dolphins is also an improvement in terms of safety. The port authority said it is investing a total of around $36 million in the positioning of dolphin configurations and the replacement of buoy berths.

In the Botlek, the port authority is replacing buoy berth 66 in the central channel of the river with a dolphin configuration. Thanks to an innovative structure – a special pontoon or 'morsponton' – it will shortly be possible to handle dry bulk at the dolphins from two sides, using floating cranes. In the Caland Canal, three existing buoy berths (81, 82 and 83) will be replaced with two dolphin configurations at dolphins 82 and 83. The new dolphin configuration 79b was already delivered a month ago a little further.

A year ago, dolphins 90 and 91 were positioned in Maasvlakte's inland lake. These dolphins have been used intensively since then, the port authority said. At the dolphin configuration – basically two sets of eight dolphins – vessels with a length of between 225 and 350 meters can moor. The maximum depth of the water is 23.65 meters NAP (New Amsterdam Water Level). Fuels and other liquid cargo, as well as dry goods such as coal and grains, can be transhipped here. In the 1980s, the port authority managed 260 buoys. Next year, when all the buoys have been replaced, the port will have 29. The new mooring buoys have four eyes instead of one. Linesmen are used to pulling the hawsers through the eye of the buoy and securing them to it. This creates a ball of rope around that one eye, which can only be released with the aid of a machete. The new mooring buoy now provides a separate eye for every hawser. That makes the process of securing and releasing vessels quick and efficient. The so-called 'holding power' of the buoy is also improved.

Competition

20 Teams Vie for Wave Energy Prize

Twenty teams have successfully navigated the first technology gate of the U.S. Department of Energy's (DOE) Wave Energy Prize to become official qualified teams. The 20 qualified teams, selected from the field of 92 official registered teams announced on July 6, will continue their quest to double the energy captured from ocean waves and win a prize purse totaling more than $2 million. The design-build-test competition is encouraging the development of game-changing wave energy conversion (WEC) devices that will achieve the DOE's goal of doubling energy captured, which will in turn reduce the cost of wave energy, making it more competitive with traditional energy solutions.

Finalist teams, which are scheduled to be announced in March 2016, will be selected based upon the requirements of Prize's second technology gate. These teams will have the opportunity to receive seed money to build their 1/20th scale WEC prototypes, which are scheduled to undergo tank testing at the nation's most advanced wave-making facility, the Naval Surface Warfare Center's Maneuvering and Seakeeping (MASK) Basin at Carderock, Md., beginning in the summer of 2016.

www.waveenergyprize.org

Official qualified teams are:

- Advanced Ocean Energy @ Virginia Tech (Hampton Roads, Va.)
- AquaHarmonics (Oakland, Calif.)
- Atlantic Wavepower Partnership (Newport, R.I.)
- Atlas Ocean Systems (Houston, Texas)
- CalWave (Berkeley, Calif.)
- Enorasy Labs (Bedford, Mass.)
- Float Inc. – BergerABAM (San Diego, Calif.)
- IOwec (MIT Sea Grant College Program) (Cambridge, Mass.)
- M3 Wave (Salem, Ore.)
- Mocean Energy (Annapolis, Md.)
- OceanEnergy USA (Sacramento, Calif.)
- Oscilla Power (Seattle, Wash.)
- Principle Power (Berkeley, Calif.)
- RTI Wave Power (York, Maine)
- Sea Potential (Bristol, R.I.)
- SEWEC (Redwood City, Calif.)
- Super Watt Wave Catcher Barge Team (Houston, Texas)
- Team FLAPPER (Floating Lever and Piston Power ExtractoR) (Research Triangle Park, N.C.)
- Wave Energy Conversion Corporation of America (WECCA) (North Bethesda, Md.)
- Waveswing America (Sacramento, Calif.)

(Gulf Coast Ecosystem Restoration Council)

$140m Proposed for

GoM Restoration Work

U.S. Secretary of the Interior Sally Jewell recently commended the Gulf Coast Ecosystem Restoration Council for issuing its initial list of proposed projects for natural resource restoration for Gulf Coast communities in the wake of the Deepwater Horizon oil spill. The RESTORE Council proposed using approximately $139.6 million from the recent settlement with Transocean Deepwater, Inc. to support restoration projects in key regional watersheds

The RESTORE Council was created under the 2012 Resources and Ecosystems Sustainability Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act), which directed the Council to dedicate 80 percent of all Clean Water Act penalties relating to the Deepwater Horizon oil spill to the fund it oversees.

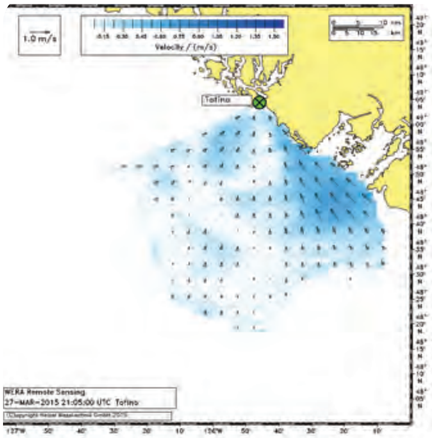
As a member on the Council, Interior was actively engaged in developing restoration proposals for the first draft of the Initial Funded Priorities List (FPL) of projects. Some of the projects focus on investments in water quality improvements and hydrologic restoration across the Gulf, which will provide direct benefits to millions of migratory birds and hundreds of federally-listed, at-risk species that call the Gulf home. Additional proposed projects include:

- restoration work to plug 11 abandoned oil and gas wells,
- backfill more than 16 miles of abandoned oil and gas canals,
- establish minimum monitoring and data standards for restoration work.

Canada Installs Tsunami Detection Radar

Ocean Networks Canada—an initiative of the University of Victoria—together with ASL Environmental Sciences Inc. of Victoria BC, Northern Radar Inc. of St. John's, Newfoundland and Helzel Messtechnik GmbH of Germany, announced the installation of a WERA NorthernRadar system that is designed to detect near-field tsunamis.

The WERA system was installed at the Tofino Airport so that tsunamis generated off the west coast of Vancouver



(Image: ASL Environmental Sciences)

Radial velocity data obtained on March 27 shows the first ocean current radial velocity data out to 85 km from shore.

Island can be measured. The radar and alerts it generates are part of the Ocean Networks Canada Smart Ocean Systems that is strengthening Canada's technological position providing ocean knowledge for sound decision making. Ocean Networks Canada is funded by the Government of Canada and includes a partnership with IBM Canada.

Teledyne RD Instruments Supplies DVLs for LAUV

Teledyne RD Instruments supplied Portugal-based underwater vehicle systems designer and manufacturer OceanScan-MST with five Explorer Doppler velocity logs (DVLs). The Explorer DVLs have been integrated on OceanScan-MST's flagship product, the light autonomous underwater vehicle system (LAUV), which is a one-man portable AUV that can be easily launched, operated and recovered with minimal setup.

New RV for University

All American Marine, Inc. (AAM) has entered into a contract with the University of New Hampshire (UNH) for the design and construction of a new aluminum catamaran research vessel. AAM will build the 48 x 17 ft. catamaran custom devised by Teknicraft Design, Ltd. of Auckland, New Zealand.

The new vessel, funded through a grant from the National Oceanic and Atmospheric Administration (NOAA) will serve the Joint Hydrographic Center (JHC) at UNH. It will join UNH's existing fleet and will complement capabilities by offering a complex multi-mission platform.

The aluminum hull will feature the Teknicraft Design signature hull shape

Facility in Focus

Makai Expands Marine Corrosion Lab

Makai Ocean Engineering is providing expanded corrosion services at its Marine Corrosion Laboratory (MCL) in Kailua-Kona, Hawaii. The MCL is located at the Natural Energy Laboratory of Hawaii Authority (NELHA), reportedly making it the only location in the U.S. where large flows of shallow and deep seawater from depths up to 3,000 ft. are continuously available. The MCL is staffed with corrosion engineers and state-of-the-art equipment for a wide range of research, development, testing and evaluation (RDT&E) services in the field of marine corrosion. Capabilities at the lab include both basic corrosion science research and applied engineering solutions for the prevention of marine corrosion, and are complemented by a strong relationship with researchers at the University of Hawaii's Hawaii Corrosion Laboratory.

The original focus of the MCL was developing marine heat exchangers. Under a contract with the Hawaii Natural Energy Institute, sponsored by the Office of Naval Research, corrosion engineers at the lab were tasked with identifying novel alloys and manufacturing methods for heat exchangers that would be corrosion-resistant, low-cost, compact and highly efficient. Samples of both ferrous and nonferrous alloys made with various joining and manufacturing methods (brazed joints and friction-stir welded joints) as well as various surface conditions (rolled, machined and extruded), have been tested at the MCL since 2009. In addition, several corrosion prevention pretreatments, coatings and techniques have been developed specifically for marine heat exchangers that are exposed to shallow or deep seawater.

The lab is now working with commercial and defense clients on testing the effectiveness of coatings that are intended for diesel storage tanks, marine pipelines and ship hulls. The MCL features an automated corrosion monitoring system that collects electrochemical, ultrasonic and laser profilometry data, as well as high resolution time-lapse photos, of in-situ samples. These data are available to clients in near-real-time via the internet. Combined with image recognition software, the facility provides real-time knowledge of sample variance and automatic detection when samples are starting to corrode, as well as a detailed time history of the corrosion process. Makai also provides destructive testing and materials characterization, and outsources standard services for metallographic imaging, scanning electron microscopy and X-ray tomography to provide clients with a convenient full service and cost effective research program.

www.makai.com


(Image: AAM)

with symmetrical bow, asymmetrical tunnel and integrated wave piercer. Power for the propeller driven vessel will be provided by a pair of Cummins QSB 6.7 Tier 3 engines rated 250 mhp at 2,600 rpm and auxiliary power will be supplied via a Cummins Onan 21.5kW generator. The suite of deck gear includes a hydraulic A-frame, davit, scientific winch, side mount sonar strut, and moon pool with deployable sonar strut.

Hawboldt Wins Tidal Winch Deal

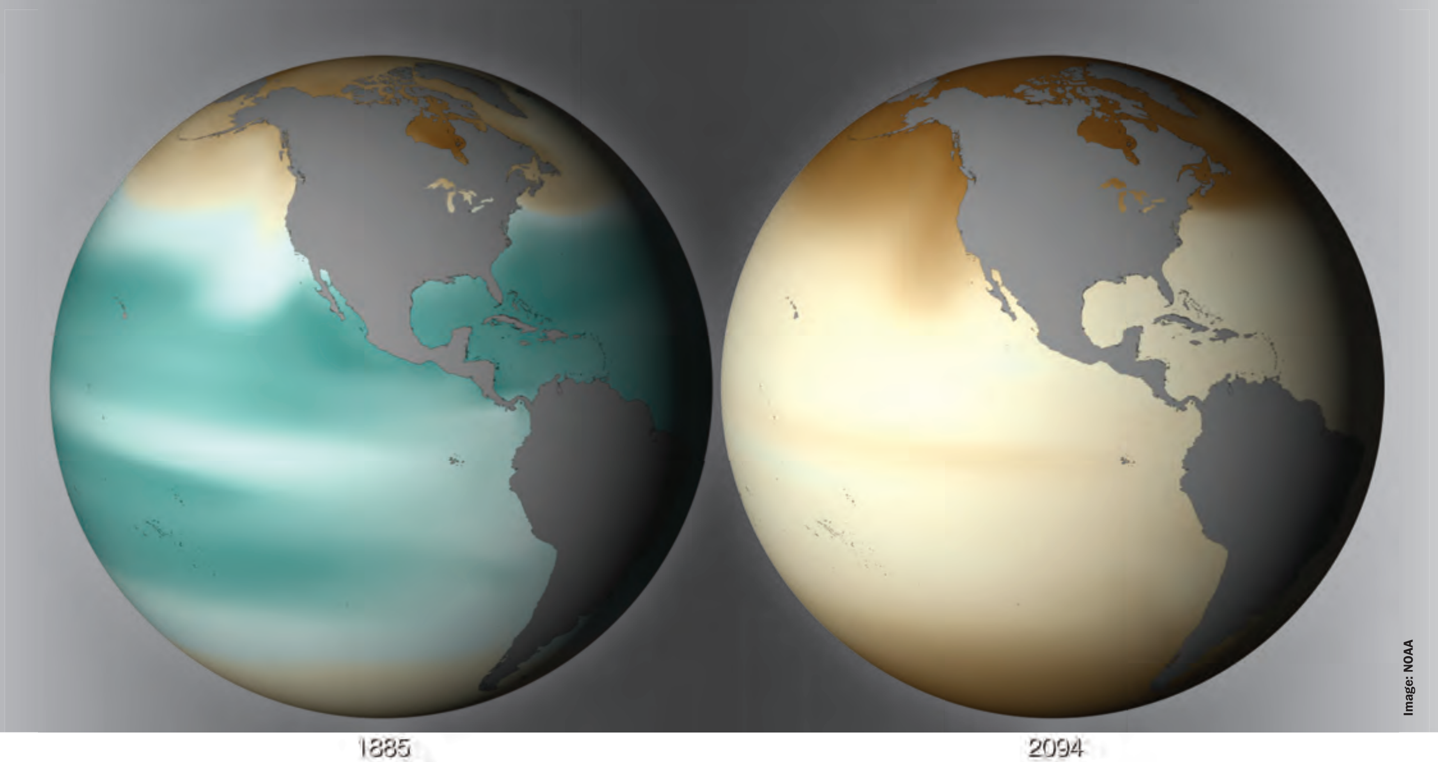
Hawboldt Industries won a multimillion dollar contract with the Cape Sharp Tidal project, which has potential to be the first grid-connected tidal array in the world. Hawboldt was awarded a $4.7-million contract for the design and manufacturing of three heavy lift winches to be used on the OpenHydro deployment and recovery barge. Cape Sharp Tidal is a partnership between OpenHydro – a DCNS company – and Emera Inc. to develop a tidal industry in Nova Scotia.

OpenHydro has extensive experience using this winch technology in turbine installations. It was first safely and successfully used in the Bay of Fundy in 2009, as well as in subsequent turbine deployments throughout Europe.

"This is an important opportunity for our business," said Hawboldt Industries GM, John Huxtable. "Cape Sharp Tidal is a major project for our region and we're happy our local expertise will be right there on the water as part of it."

In its first phase, Cape Sharp Tidal will deploy two, 2MW, grid-connected turbines off Parrsboro, NS later this year. The project aims to progress in phases toward a 300MW, commercial scale industry in the 2020s.

Ocean Acidification



By Dennis L. Bryant

Image above:

The NOAA View imagery portal provides a single point for experiencing NOAA data from satellites, models and in-situ analyses. The site allows for seamless browse, animate and download capability of high resolution images and Google Earth formatted files. With over 60 datasets (and growing) that go as far back as 1880 and out to 2100, NOAA View provides the ability to see our dynamic planet and how it changes over weeks, months, years and even decades. One example of this change is illustrated in these images, taken directly from NOAA View. The two globes illustrate the changes in ocean acidification that are expected as the ocean continually absorbs carbon dioxide from the atmosphere. As more and more carbon dioxide reacts with water, the building blocks of the calcium carbonate shells used by so many marine organisms either dissolve or cannot form to begin with. The availability of these building blocks (called aragonite; a form of calcium carbonate) is shown here. Areas of the ocean colored green are sufficiently saturated with aragonite to support shell formation; areas colored yellowish-brown are under-saturated, and shell dissolution occurs. A climate model, run by CESM in collaboration with scientists at NOAA PMEL, shows the change in ocean aragonite saturation from 1885 to what is expected in 2094. Most of the ocean in the image on the right is uninhabitable by organisms using calcium carbonate, such as corals, pteropods, oysters and many others.

Scientists say that the world's oceans are acidifying. This term is correct, but somewhat misleading. Until recently, the oceans have had (so far as can be determined) a pH level of about 8.4 for millennia. A pH of 7.0 is neutral. Thus, the oceans are alkaline, not acidific. But, since the beginning of the industrial age when emissions of carbon dioxide started to rise, the oceans' pH level has dropped to 8.3 and the waters have become less alkaline. Some argue that that is not a big change in 200 years. But it is the largest change known to have occurred in 20 million years. In addition, most of that change has occurred during the past 50 years and the rate of change is accelerating, keeping pace with the increase in carbon dioxide emissions. It has been estimated that the average pH of the oceans will fall to 7.8 by the end of the 21st century if the carbon dioxide emissions trend continues.

Why do we care? We don't live in the ocean and we don't drink seawater.

We care because there is only one Earth and one biosphere. Oceans cover about 70 percent of the Earth's surface and constitute more than 90 percent of the biosphere (that portion of the Earth capable of supporting life). Many chemical reactions, including those essential to life, are sensitive to even small changes in the pH level. A small change in the pH of seawater can have harmful effects on marine life, impacting chemical communication, reproduction and growth.

Ocean carbonate chemistry is a natural buffering system, but this buffering capacity is being compromised as a direct result of carbon dioxide absorption by the oceans.

The dissolved forms of carbon dioxide – carbonic acid, bicarbonate, and carbonate – have a significant impact on seawater pH levels because their concentrations are rapidly absorbed and distributed compared to other seawater constituents.

As the oceans uptake the increased amounts of carbon dioxide from the atmosphere, a portion converts into carbonic acid, thereby reducing the alkaline level of the water. Higher acidity of the oceans can reduce the ability of some marine species to mature and form shells and it can alter their physiology or behavior, affecting growth, fertilization, embryonic/larval development and survival. It impacts marine ecosystems by such means as disrupting predator and prey relationships in food chains and altering habitats, including by degrading barrier reefs that protect coastal areas. Over time, lowering of pH levels can damage local economies by disrupting fishing and tourism.

Higher levels of carbon dioxide in seawater cause chemical reactions that reduce the saturation state of calcium carbonate minerals such as aragonite and calcite. Many marine organisms, including oysters, clams, starfish and zooplankton, as well as some plants and algae, construct their shells and other structures from these minerals. As the saturation state approaches, these minerals are leached out of the shells and other structures, having potentially fatal consequences. Even if the organism survives, it must devote more energy to shell/structure grow and maintenance, leaving less energy available for reproduction and other activities. Disrupting the calcium carbonate cycle not only impacts these animals, it has adverse effects on the entire marine ecosystem.

The pH level of the blood in marine animals is lower than the pH level of the seawater. Ocean acidification reduces the difference between those two pH levels, with adverse consequences. Respiratory proteins in the blood, such as hemoglobin, bind oxygen at high pH and release oxygen at low pH. This allows oxygen uptake at the gills or similar structures and oxygen release at the cells, where metabolically-produced carbon dioxide has decreased the pH. If the pH levels at the gills and at the cells are similar, a condition called respiratory acidosis results and death can occur.

Most, but not all, marine plants and algae will probably suffer few adverse consequences from a moderate lowering of the pH level of seawater, but further research is required. What is known is that ocean acidification reduces biodiversity, ultimately causing adverse impacts throughout the biome.

In 2009, Congress adopted the Federal Ocean Acidification Monitoring and Research Act (FOAMRA). This statute established an ocean acidification program within the National Oceanic and Atmospheric Administration (NOAA) and directed comprehensive research on the processes and consequences of ocean acidification on marine organisms and ecosystems.

As the statute's name indicates, it only authorizes increased and coordinated monitoring and research relating to ocean acidification. Active measures to reduce or ameliorate ocean acidification must be undertaken under separate pre-existing or subsequently adopted statutory authority.

The problems posed by ocean acidification are not local or even regional. They are worldwide. Halting or reversing this process requires global action, principally involving the reduction of carbon dioxide emissions.

Needless to say, this will be a heavy lift.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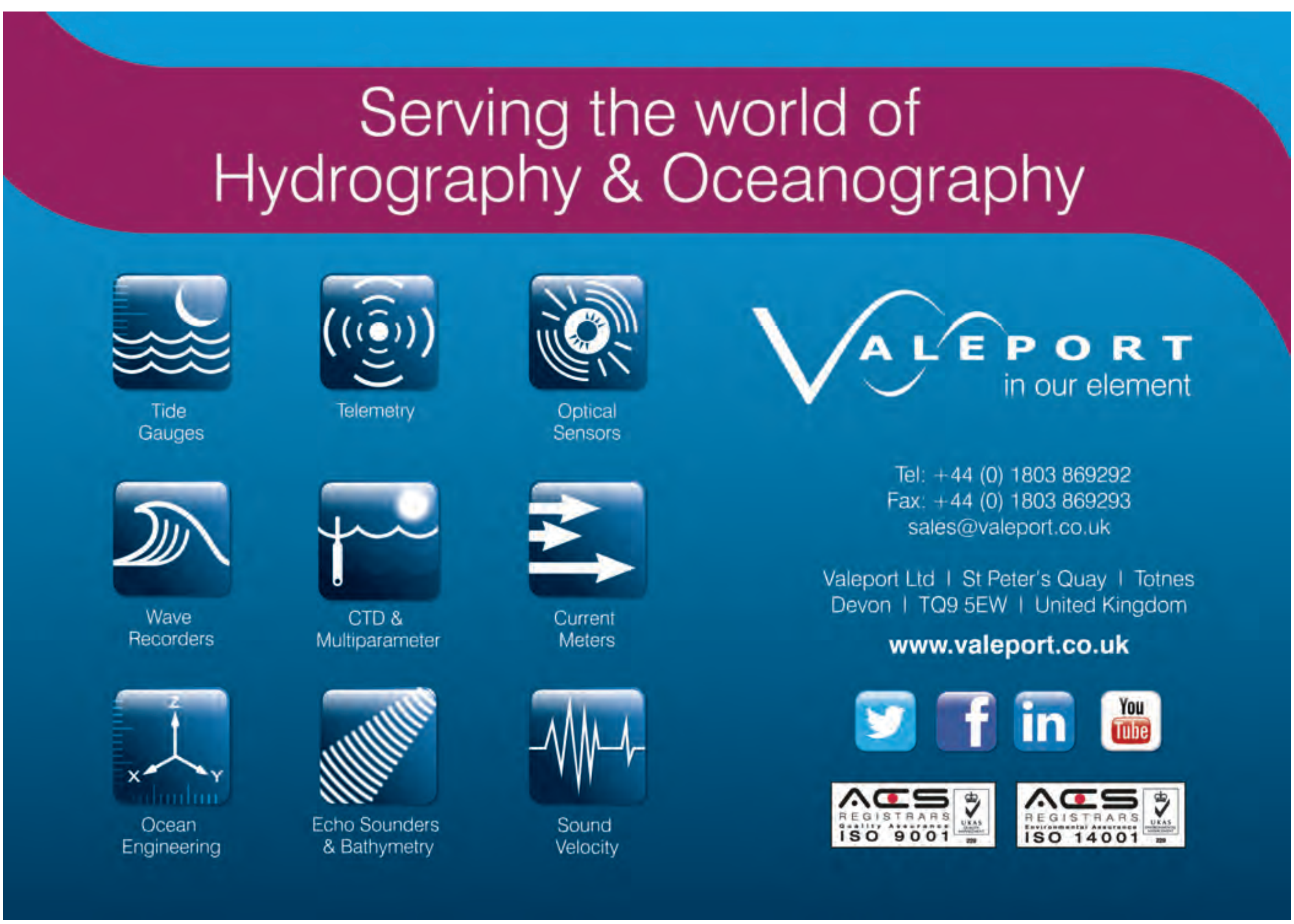
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Riding the Waves and Tides to a Cleaner Energy Future

By Joan M. Bondareff, Of Counsel, Blank Rome LLP

The first of 177 London Array foundations was installed in March of 2011. Turbine installation followed throughout 2012.

(Credit: London Array Limited)

When one thinks of offshore renewable energy, one usually thinks of offshore wind. For the first time progress is being made in the U.S. to develop offshore wind resources. The first steel foundation jacket has been placed in the ocean floor to support the Deepwater Wind project off the coast of Block Island, Rhode Island. (See www.dwwind.com/press/#/1). But recently, progress is also being made in the development of tidal and wave energy resources closer to shore, which are known as marine hydrokinetic or MHK resources. MHK projects generate electricity from waves or directly from the flow of water in ocean currents, tides or inland waterways. Ocean thermal energy is also part of the MHK equation but has not been actively pursued in recent years.

MHK Potential

The Department of Energy (DoE) has reported the following available MHK resources close to the U.S. coastline:

1.) The technically recoverable resource for electric generation from waves is approximately 1,170 terawatt-hours (TWh) per year which is almost one third of the 4,000 TWh of electricity used in the U.S. each year. Approximately 85,000 homes can be powered by 1 TWh/year.

2.) The technical resource potential for tidal generation is estimated to be 250 TWh/year. Alaska has the most locations with high kinetic power density, followed by Maine, Washington, Oregon, California, New Hampshire, Massachusetts, New York, New Jersey, North Carolina, South Carolina, Georgia and Florida.

3.) The technical resource potential for electric generation from ocean thermal resources is estimated at 576 TWh/year in U.S. coastal waters, including all 50 states, Puerto Rico and the Virgin Islands.

With support from the federal and state governments and industry, these resources could provide an excellent source of renewable energy for generations to come.

Funding Availability, Projects and Permitting of MHK Resources

Funding to support the development of MHK technology is available from both DoE and the Navy, and the two agencies often combine their resources to promote this new energy resource.

The Navy has its own test site for wave energy in Kaneo-

The Meygen tidal stream energy project is currently under construction off the coast of Scotland. By the early 2020s, MeyGen Limited intends to deploy up to 398MW of offshore tidal stream turbines to supply clean and renewable electricity to the U.K. National Grid. **(Credit: Atlantis Resources Ltd.)**

he Bay on the island of Oahu, Hawaii. Last year, the Navy awarded $8 million to the University of Washington to develop marine renewable energy for use at the Navy's facilities worldwide. This is intended to help the Navy meet its commitment to get one-half of its energy from renewable sources by the year 2020. (http://www.washington.edu/news/2014/10/24/u-s-navy-awards-8-million-to-develop-wave-tidal-energy-technology/).

In July 2015, the Office of Energy Efficiency & Renewable Energy of the DoE announced that a prototype wave energy device, called *Azura*, developed by Northwest Energy Innovations of Portland, Oregon, has advanced successfully from initial concept to grid-connected, open-sea pilot testing. *Azura* was recently launched and installed in a 30-meter test berth at the Navy's Wave Energy Test Site in Hawaii. The test will allow researchers at the University of Hawaii to evaluate the long-term performance of the nation's first grid-connected wave energy converter device. The device will also be feeding renewable electricity to Marine Corps Base Hawaii. (http://energy.gov.eere/articles/innovative-wave-power-device-starts-producing-clean-power-Hawaii/).

Other wave energy device tests, supported by a total of $10 million in funding from DoE in 2014, include an Ocean Energy Buoy developed by Ocean Energy USA of Sacramento, CA. (http://energy.gov/eere/articles/energy-department-announces-10-million-full-scale-wave-energy-device-testing).

Just last month, DoE awarded an additional $7.4 million to develop advanced components for wave and tidal energy systems, including awards to Virginia Tech and Penn State University. The purpose of the funding is to help improve the performance and reduce the cost of MHK technologies. (http://energy.gov/eere/articles/energy-department-awards-74-million-develop-advanced-components-wave-and-tidal-energy.)

If a MHK project is located in state waters, permitting is provided by the Federal Energy Regulatory Commission (FERC). FERC's authority to regulate MHK projects in state waters is derived from Part I of the Federal Power Act (16 U.S.C. 791a et seq.). A user-friendly guide to FERC's licensing procedures is available at: www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp. MHK development in federal waters is regulated by the Department of the Interior's Bureau of Ocean Energy Management (BOEM), but no projects have yet emerged in federal waters.

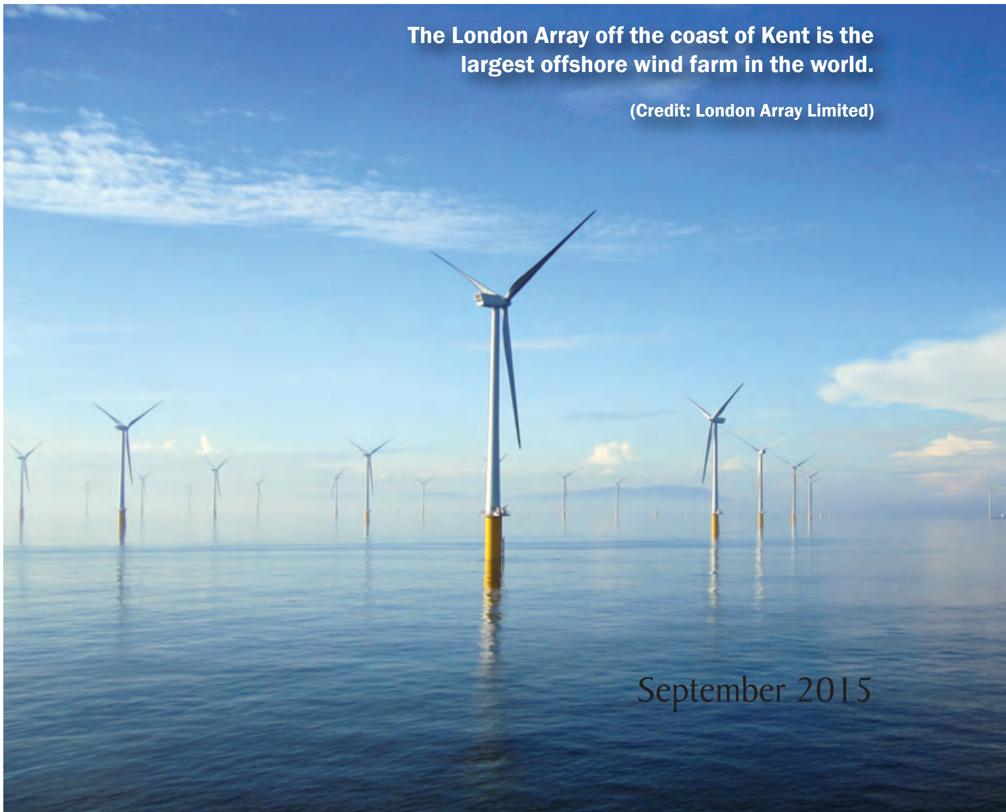
As of July 10, 2015, FERC had issued eight preliminary permits – two tidal, three wave and four inland MHK projects; four licenses for tidal pilot projects; and four projects were in the pre-filing stage. The eight preliminary permits include two projects in the Niagara River; three in Alaska (Kvichak River, Cook Inlet, and the Gulf of Alaska); two in Morro Bay, CA; and one in Ft. Pierce Inlet, FL. The fully licensed projects include Verdant Power's tidal project in the East River, NY; a project in Admiralty Inlet, Puget Sound, WA; ORPC Maine's tidal project in Cobscook Bay, ME; and Whitestone Power's tidal project in the Tanana River, Alaska.

Impediments to and Future Development of MHK Technologies

The President's budget for FY'16 requested $40.8 million for these programs, a decrease of $300K from FY'15. As of this writing, the House has appropriated only $21.8 million for MHK, but the Senate has increased the budget for MHK support to $42 million. The Senate funding includes $20 million for a balanced portfolio of competitive private sector-led research, development and demonstrations and $5 million for an open water, fully grid-connected wave test facility. Unfortunately, it is likely that Congress will adopt a Continu-

The Meygen tidal stream energy project.

(Credit: Atlantis Resources Ltd.)



The London Array off the coast of Kent is the largest offshore wind farm in the world.

(Credit: London Array Limited)

ing Resolution or CR for at least part of FY'16 and perhaps even all of the fiscal year which will hamper any new program starts and could limit grant opportunities.

Some states have provided support for MHK projects but this is, understandably, largely dependent on their location and proximity to tides and waves. For example, the NYS Energy Research and Development Authority (NYSERDA) has actively supported Verdant's Roosevelt Island tidal project at Roosevelt Island in the East River, NYC. (www.nyserda.ny.gov/Partners-and-Investors/Clean-Energy-Startups/NYSERDA-Catalyzes-Investments/2012-07-02-Verdant-Power). Alaska has been supportive of the tidal power being developed in Cook Inlet, which is estimated by ORPC of Alaska to have 90 percent of the U.S. total tidal power potential. (www.orpc.co/content/aspx?p=Yojopy2b9VQ%3D).

Maine has been supportive of ORPC Maine's tidal energy project in the Bay of Fundy. (www.orpc.co/content.aspx?p=h3jCHHn6gcg%ed). This project alone has been estimated to have injected $21 million into the Maine economy and supported more than 100 jobs in 13 Maine counties. (http://www.3degreesinc.com/projects/renewable-energy-projects/maine-tidal-energy).

The recently-reported Senate Energy Policy Modernization Act of 2015 has a separate section to promote the development of MHK resources through the establishment of new demonstration centers, and an increase in the authorization levels for these programs. (Sections 3013-3016.) But, of course, it remains to be seen what funds are actually appropriated.

The FERC permitting process, while thorough, has perhaps been slower than some applicants might like; however, the agency has issued a number of licenses for pilot projects.

In summary, companies are left largely on their own to develop, fund and promote MHK technologies with limited federal and state support. However, with the expected progress for wave power in Hawaii at the Navy's test site, and reasonable progress in NYSERDA, Maine and Alaska for tidal power, perhaps we will see other companies enter the fray and produce more innovative and cost-effective technologies. These resources can certainly complement the growth in wind and solar that the U.S. has experienced in recent years. They can also play a role in helping states with wave and tidal power potential to implement the new Clean Power Plan that President Obama announced on August 3, 2015. (https://www.whitehouse.gov/climate-change).

Maritime Surveillance in the New Millennium

By Marianne Molchan, President, Molchan Marine Sciences (MMS)

In 2014, Forbes Associate Director for Maritime Services at Control Risks stated that maritime risks are on the rise. Mariners and ship owner/operators experienced a 26 percent spike in maritime piracy and armed robbery since 2014 and the North Sea Oil Industry admitted that it had been targeted and thwarted cyber attacks, attacks that if successful could have caused untold financial and logistical damage. While most of us see these security incidents in news snippets, consider:

- Tankers are still being hijacked and emptied at sea in alarming rates;
- A plot to bomb the Suez Canal was revealed in 2015
- Oil companies are installing surveillance equipment protecting rigs in response to perceived threats
- Within the last decade, plans to attack a cruise ship in a major U.S. port were revealed.

Maritime surveillance systems play a key role monitoring sea lanes and ports while supporting worldwide maritime safety and security.

Situational Awareness & Operational Effectiveness

The ability to operate effectively and securely in any environment (air, land or sea) depends on an acute awareness and understanding of the surrounding elements. Military, law enforcement and port security specialists pride themselves in maintaining a high level of situational awareness (SA). Their lives depend on the ability to accurately predict the status of the surrounding elements within a measurement of time and space. Today's port security officials, naval personnel and U.S. Coast Guard Ship Captains and Sector Commanders all use an electronic display of data and sensor information providing real-time situational awareness. The source data supporting these maritime surveillance systems may include cameras, radars, sonars, Automated Identification Systems (AIS) and real-time crowd sourcing data. An excellent surveillance system offers data clarity within a common operating picture supporting operations and appropriate security responses in emergency situations. This article provides clear guidance to companies in the process of ***seeing though the clutter*** in the development or selection of an operationally effective coastal surveillance system and sensor integrator.

Challenges in Developing Maritime Surveillance Systems

Making multiple sensors form one cohesive situational awareness picture is not just about the sensors. The genesis of an effective SA system begins with clearly identifying the problem(s) that need solving. *A clear definition of the problem and performance requirements for the system is the first challenge.* Once the end user has defined the Concept of Operations (CONOPS) the experienced integrator will choose appropriate sensors based on a number of factors, including but not limited to:

- Area of Coverage (sectors, 360 degrees, land, sea, air, distance from shore, overlap, blind spots)
- Environmental Factors (weather, marine life, sea and land clutter, water temperature, salinity)
- Duration of Coverage (day, night, months, years)
- Restrictions (power, staff, passive vs active sensors)
- Target Behavior (speed, track, medium, distance)
- Sensor Limitations (side lobes, signal strength, data storage, bandwidth, range)

Some of the challenges are as basic as getting the sensor feeds to literally plug into one another and play well together. Cross correlation of multiple sensors is an art form. Once a target is identified on one sensor, it may or may not be seen on other sensor types depending on the sensor settings, time of day, sensor capability and vulnerability etc. *Determining the most appropriate sensors and sensor placement for the surveillance system requires seasoned sensor integrators.* In order to get reliable and consistent target identification under a variety of conditions, multiple types of sensors may be required. Sensors typically have certain conditions under which they perform optimally. For example, infrared cameras provide a reliable tracking of "warm" targets in no or low light conditions where a daylight camera may not.

Many first and second generation maritime surveillance systems are in need of upgrades. During the lifetime of a surveillance system, legacy sensors may need to be merged or work in conjunction with new sensors. The modernization of the USCG Fleet

C2 sensors mentioned later in this article is a perfect example.

A surveillance system secure from interceptors, or cyberattacks is paramount. In an effort to underscore the importance of cybersecurity within maritime environment in June 2015 the USCG published a document entitled Cyber Strategy which outlines the defense of cyberspace, enabling operations and protecting infrastructure. *While cyberattacks are a known threat and some protections are available and in place, it is the author's opinion that more attention could be paid to securing integrated sensor systems.*

In designing and evaluating a multi-sensor SA systems objectives include but are not limited to:

- *Scalability and interoperability meeting future expansion while leveraging existing systems*
- *Flexible sensor solutions for a variety of platforms, environments and data links*
- *Sensors with complementary capabilities and limitations*
- *Abstracting specific sensors behavior and characteristics from the end-user (providing illusion of Plug & Play)*
- *Consistent / accurate performance in all weather conditions*
- *Filtering raw data and information; displaying what's pertinent to the mission*
- *Multi-sensor track processing and correlation*
- *Reliable target information supporting operator decision making*
- *Real-time anomaly detection / alerting for operator incident recognition*
- *Capability for sharing information with other systems.*
- *User friendly operation and maintenance*
- *Ongoing customer support and open feedback loops*

Examples of Sensor Integration

Core system capabilities that tie the sensors to the user display are often developed and maintained by agile sensor integrators. SSR Engineering Inc. is considered by many in the defense and maritime surveillance industry to be a prime example of a capable, responsive sensor integrator providing everything from portable stand-alone systems using non-terrestrial communications to large scale multi-site sensor installations. SSR Engineering's personal computer based radar processor (PCRP) is an example of a "black box" that is the functional backbone of multiple national and international maritime and shipboard surveillance systems, port security, offshore platforms and range safety systems. Used by both military and civilian clients, the value in the PCRP lies in the fact that it seamlessly interfaces with most modern and legacy radars and Identification Friend or Foe (IFF) systems.

Following are some prime examples of how the design and customer feedback loop to a SA system creates optimal performance.

Maritime Law Enforcement Information Network (MLEIN) Protecting Natural Resources

Maryland's Department of Natural Resources uses SSR Engineering's surveillance system to protect valuable oyster beds (photo left) in the Chesapeake. Land based radars, shipboard cameras, and portable sensor systems are monitored by the Natural Resources Police. The network uses 4G, Wi-Fi, Microwave and terrestrial data links providing target data, AIS and Blue Force tracking in a cohesive track picture. The sensor rich system covers the Chesapeake Bay from the Susquehanna River to the Virginia state line.

SSR provides lifetime customer support to the MLEIN owner/operators. Ongoing customer support generates a valuable feedback loop. The experienced MLEIN operators continue to provide system improvement requests that contribute to tailored system enhancements.

Boosting Vessel Surveillance in the Port of Long Beach– Enhancing Surveillance to Detect Small Targets

Based on small boat attack tactics navies worldwide have been paying close attention to small boat behavior within a port. The Port of Long Beach determined they needed additional sensors to provide this key missing component to their Port Security System. SSR Engineering created a system supporting multiple missions simultaneously through a set of processing and display filters used specifically for the purposes of tracking small vessels. This provided port security personnel much needed mission specific information. Existing radar sensors were monitoring and tracking the larger vessel entering

Port of Long Beach Security System Screen

and exiting the port but the new radar system provided a second layer of security supporting ongoing patrols by the USCG and Long Beach Marine Police. The combination of additional radars and radar processors feeds vital information into the port security operators, C2 Center and Jacobsen Pilots.

This system includes a centralized alarming capability that monitors the small boat tracks and provides a real-time alerting function. These alerts include geo-fences, closest point of approach, proximity zones, loitering zones and anchor watch.

USCG Fast Response Cutter with C2 System

Modernization of the USCG Fleet-Merging Old and New Systems and Capabilities

USCG shipboard C2 systems incorporate SSR Engineering technologies allowing operators to use the ARPA interface augmented with tactical features and functions.

As a result, the C2 system is scalable, interoperable and suitable for future expansion while leveraging the existing systems. Because of SSR Engineering enhancements, the USCG installed their radars of choice without worrying about prohibitive integration issues. The system includes an identification friend or foe transponder, an Automatic Identification System (AIS), electro-optical / infrared sensor system, surface search radar and air search radar. Depending on the mission at hand, these technologies allow operators to quickly identify threats, violators, or distressed vessels and coordinate joint response operations.

Securing Offshore Platforms- 360 degree Integrated Sensor Surveillance, Detection and Alerting Systems for Mobile Operators

With a worldwide movement towards minimal manning and the need to provide 360 degree protection for vessels and offshore platforms, the future in maritime security systems lies in sophisticated alerting capabilities. SSR Engineering technologies provide sensor solutions for a variety of platforms, environments and data links creating an interconnected set of patrol boats and platforms. The platform acts as the command center which is capable of sharing radar and track information with patrol boats.

SSR's surveillance systems include custom alerting capabilities delivering alarms and threat alerts via email, Short Message Service (SMS), Multi-Media Messaging Service (MMS) and Simple Network Management Protocol (SNMP) to assist operators working with mobile devices. They have incorporated alerting systems such as Long Range Acoustic Devices (LRAD) and AIS with their Radar, Camera and Sonar surveillance systems. With the use of AIS and LRAD, the operator can provide direct notification or warning to the target. The SSR Composite Tracker correlates target information from multiple sensors providing an accurate track picture while alarm zones based on proximity and predetermined characteristics detect and trigger events like slewing cameras or LRADs towards the threat and send out a warning.

Remote monitoring and control capability sending sensor data and control messages over low-bandwidth radio and satellite links provide owner/operators of platforms an additional surveillance capability.

Conclusion

A primary goal of a robust SA system is to sharpen the operator's perception of the surrounding environmental elements with respect to time and/or space. Experienced operators of robust SA systems find them essential to surveillance, detection, classification, identification and potentially prosecution of a target. Engineering companies that provide software that produces organized data fusion from multiple sources essentially create a reduced operator workload, enhanced decision-making and essential mission management.

Essential concepts for developing a maritime surveillance system are provided in this article. A review of some of the key points are provided below:

- *The first challenge in developing maritime surveillance systems is understanding and defining the customer's prob-*

lem and performance requirements.

- *Determining the most appropriate sensors and sensor placement for the surveillance system requires seasoned sensor integrators.*
- *Each sensor has specific capabilities and limitations. The multi-type sensor approach will achieve consistent performance under all conditions.*
- *A surveillance system secure from interceptors, or cyber attacks is paramount.*
- *Ongoing customer support generates a valuable feedback loop. Experienced operators can provide SA system improvement requests contributing to tailored system enhancements.*
- *Multi-mission support capability using a set of processing and display filters allow each operator to see the pertinent information they have requested for their mission.*
- *With a worldwide movement towards minimal manning and the need to provide 360 degree protection for vessels and offshore platforms, the future in maritime security systems lies in sophisticated alerting capabilities.*

The Author

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Tackling Subsea Blockages

By Angus Macaulay

Subsea blockages are a common industry challenge that can be so complex and costly to treat that some operators are known to leave multiple flow lines blocked for over a decade.

This issue is set to become more challenging to solve, as we deal with complex reservoir conditions and fluids and more challenging flow-assurance conditions. With oil and gas production venturing into deeper waters, increasing tie-back distance, higher temperatures and greater pressures, the remediation of restrictions and blockages in subsea pipelines will become more difficult to combat as time moves on.

Within subsea infrastructure, blockages can affect risers, flow lines, pipelines, umbilical, pipeline end terminations (PLETS) and manifolds. Blockages can occur for a variety of reasons and some simply come down to a lack of infrastructure maintenance. Whatever the cause, the effect can be a significant loss of revenue with far-reaching consequences.

A buildup of wax, scale, asphaltene or hydrates will severely affect production and hamper field profitability. Remediation methods are historically costly and include deploying a coiled-tubing system from a rig into the pipeline or undertaking subsea intervention via remotely operated vehicle (ROV) or saturation divers. The requirement for a rig or vessel to undertake the work can also significantly delay the time to implement a solution, further contributing toward making these options uneconomical. Replacing the pipeline can be a time consuming and costly exercise to undertake. The blocked line would still require decontamination as per the Department of Energy and Climate Change

(DECC) requirements prior to decommissioning and retrieval.

Enter Pipe Pulse

One international oil company operating in the North Sea suffered persistent blockage on a 15 kilometer flow line for 11 years and lost an estimated 350 barrels per day. Another had a subsea flow line blocked for 10 months with sand and wax. Located 16 kilometers from the host platform, the six-inch multiphase flow line lay at a water depth of 100 meters. This operator had tried a variety of conventional methods to tackle the issue, but due to the remote location of the blockages from the host platform, access to the pipelines and the subsea infrastructure proved difficult. A number of topsides and subsea issues were left unsolved.

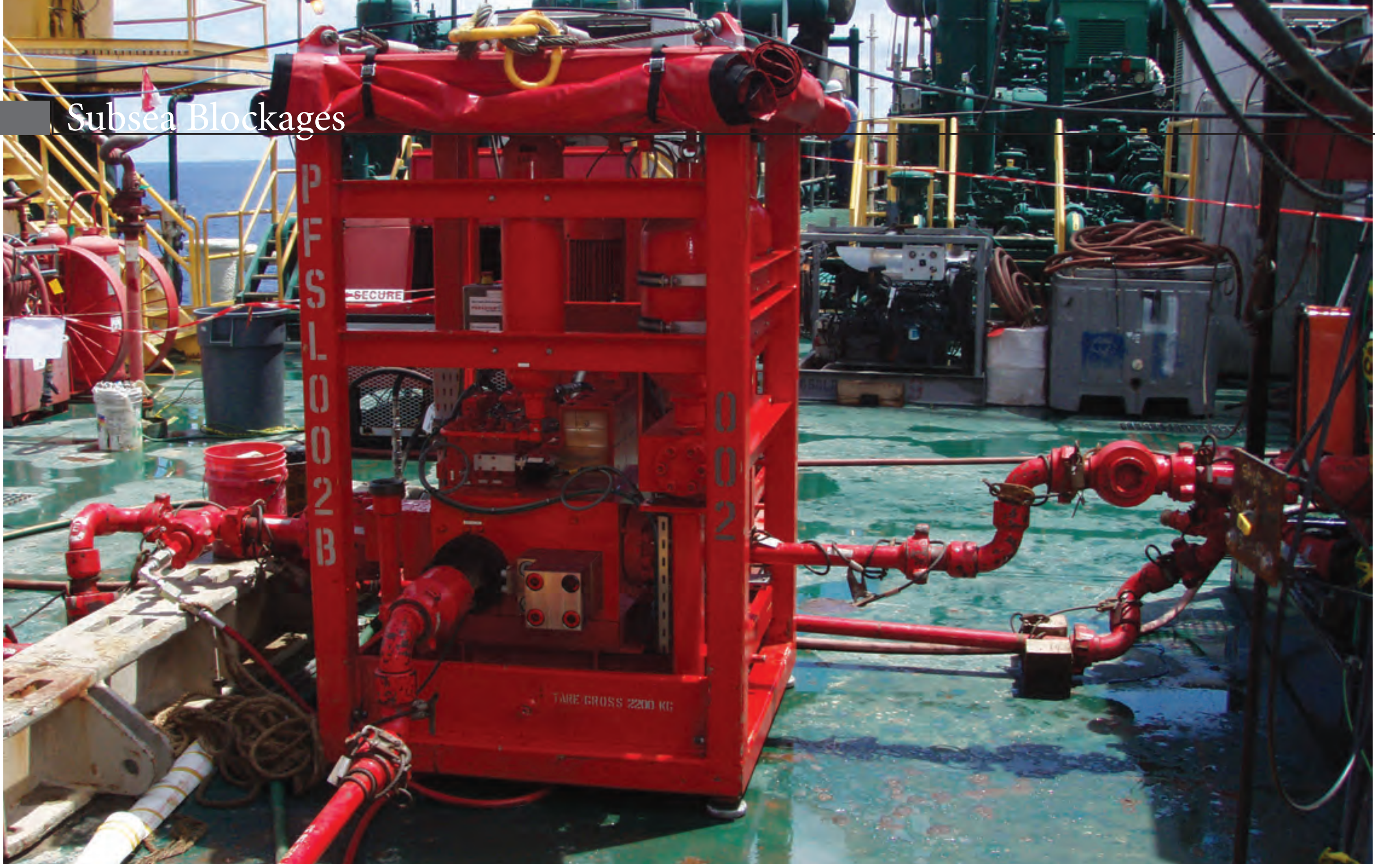
A nonintrusive removal of subsea blockages was needed, and the solution was the Pipe-Pulse flow oscillation method. Deploying this type of technology cleared the blockage in all these examples and lines could be flushed within 2.5 days. It took less than a week to unblock multiple flow lines in this central North Sea field.

During the test phase of its development, Pipe-Pulse had accurately detected a blockage for an operator in the North Sea which turned out to be a collapsed flexible jumper 10 kilometers into the gas lift line of an umbilical. This knowledge saved the client an estimated $600,000 for not having to mobilize a DSV to investigate the blockage.

Pipe-Pulse has also been used to solve a number of paraffin wax blockages in the Gulf of Mexico, and the unblocking operations let oil companies get their wells back online. In one case, the blockage occurred in a 16-mile, five-inch flow line, and the operator had failed to unblock the blockage despite six months of trying. Pulsing cleared the blockage in two weeks and full-flow resumed without the need to shut down the flow line.

Gulf Interventions

A high-frequency low-amplitude flow oscillator for the removal of blockages in pipelines and umbilical offers a low cost solution which completes in days rather than months with



Risk-avoidance: Pipe-Pulse units set up to start pulsing against a blockage.

minimum vessel requirements. A rapid response service also minimizes HSE exposure, reducing the requirement for diver intervention programs, and diver intervention inside lines that might have trapped pressure.

Typical blockage locations include chemical injection umbilical, production risers, manifolds, flow lines and pipelines. Pipe-Pulse is effective in all of these applications even in long-distance or large-diameter pipework.

Pipe-Pulse works remotely and can locate and remove blockages in pipework up to 50 kilometers distant. This deblocking system is designed to be connected on the topside facilities of a host platform via the pig launcher or umbilical termination unit. The unit delivers high-energy and high-volume pressure pulses into the pipeline or subsea umbilical. These pulses transmit at the speed of sound to the blockage miles away. Four engineers on a unit per shift control the length and pressure of the pulse.

Steady pulse

The Paradigm system uses a touch-screen panel to operate a complex series of control valves in the body of a Pipe-Pulse unit. Algorithms determine the optimum wave structure for each pulse from potentially millions for each particular job. The unit then physically creates and injects the manufactured pulse into the pipeline, a far more effective method than applying pressure alone.

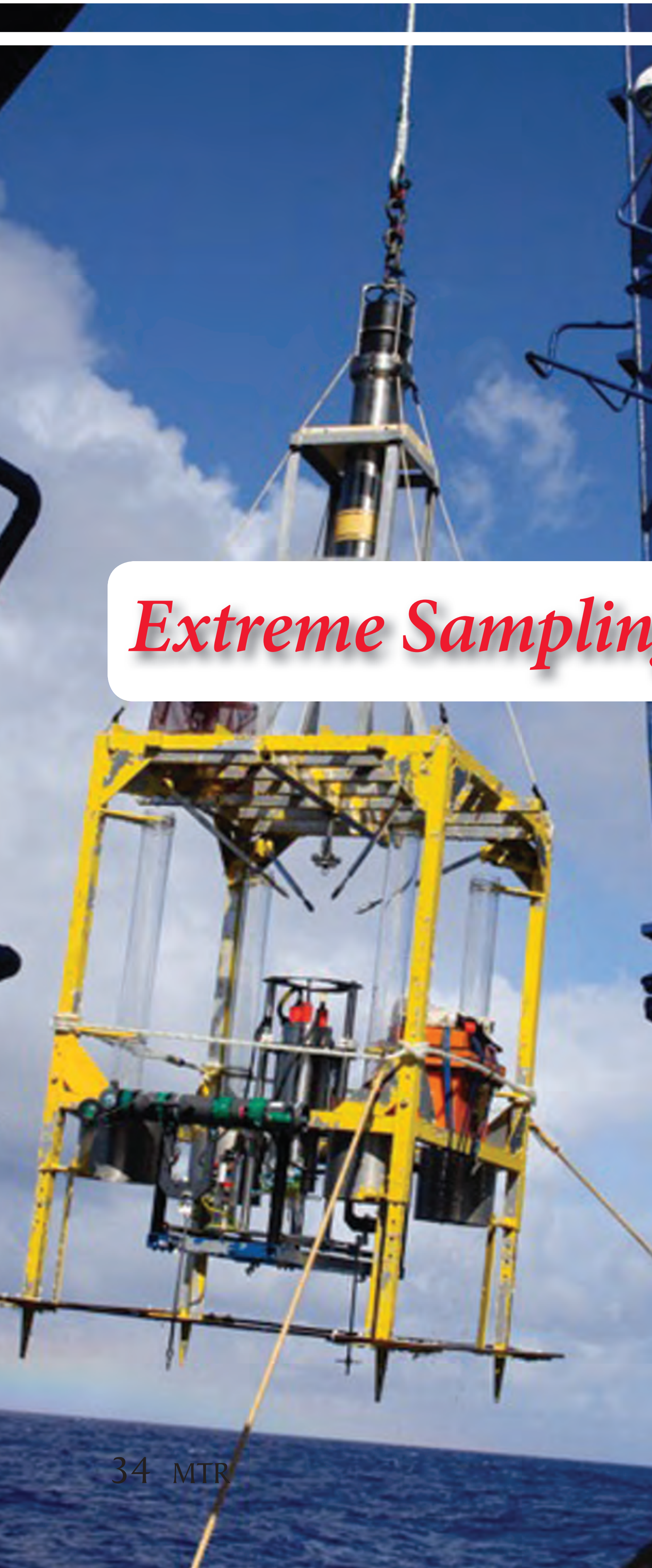
While water is the fluid of choice, a number of chemicals have been used where water incompatibility is an issue. Solvents and monoethylene glycol have been used successfully where required, but these are avoided due to handling issues.

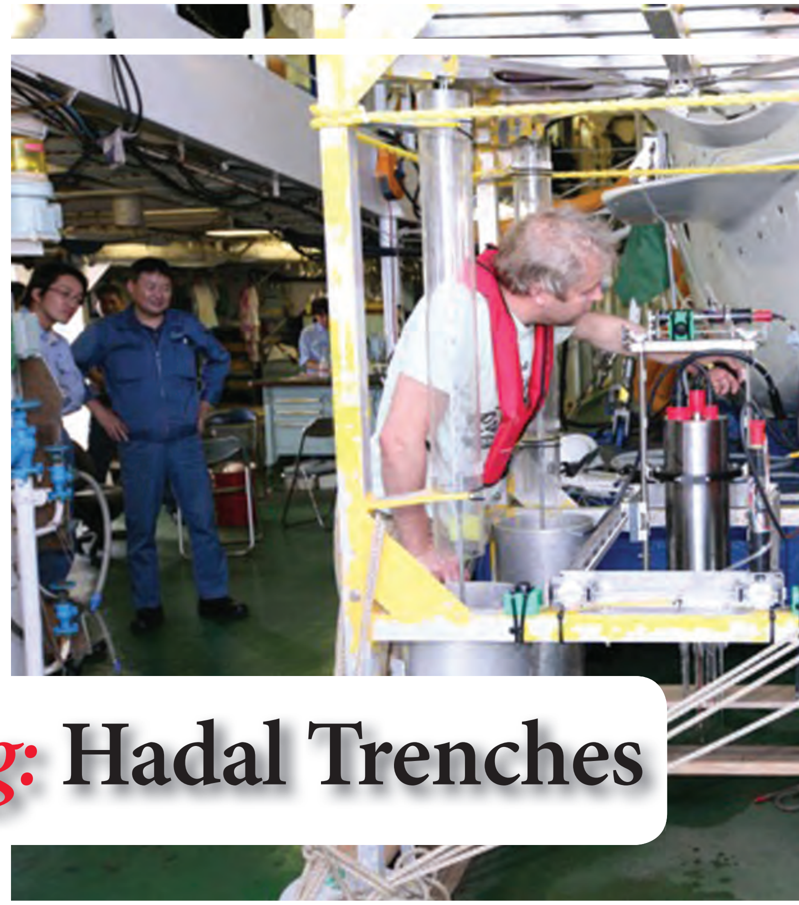
Each debris removal ought to be uniquely engineered depending on the subsea infrastructure, and that's what Paradigm does. Sometimes, a blockage can be pushed to a larger flow line and circulated out. Occasionally, flushing heavily with chemicals may be necessary once a bypass has been achieved, or flow from a well can be brought on to flush debris back to the surface.

Space is often at a premium offshore. The Pipe-Pulse is just one meter wide by two meters tall and fits into the most cramped Zone 1 hazardous area. The two units needed for operations are 1,763 pounds each yet still achieve flows of five barrels per minute while operating at 10,000 psi.

Deeper water, complex reservoirs and aging equipment all push prices up. This solution from paradigm solves at least one expensive problem cost-effectively, and in deep water, the Pipe-Pulse delivers dramatic savings. Where chronic obstructions have gone unresolved for years, millions of dollars can be saved by not having to replace umbilical or pipeline.

Material clog: Paradigm Offshore Supervisor at work.





Extreme Sampling: Hadal Trenches

Deep-sea trenches represent one of the most extreme marine environments in the world. Although a subject of fascination for many scientists and ocean explorers, until relatively recently, they remain virtually unexplored due to the technical challenges in operating instruments and collecting samples at these extreme depths. Recent advances in underwater vehicles, image capturing and sampling technologies are increasing the opportunities for researchers to observe and uncover the mysteries of the deep. A team of international deep-sea scientists and engineers have embarked on a mission to build novel robots to explore and retrieve intact samples from the deepest parts of the ocean in a bid to discover how life is sustained thousands of metres below the ocean surface.

It was only in the last 50 years that advancements in technology have highlighted the importance of deep-sea environments in the carbon cycle. Deep-sea sediments represent an important compartment of this process - as organic matter settles onto the seafloor, it is either mineralized or buried into the sediment. One of the major challenges obstructing deep-sea research is inability to collect the samples required to understand biological processes at these extreme depths. Organisms that survive extraction from their natural environment do not necessarily considered important, while others are inevita-

bly affected and typically killed due to changes in pressure.

While exploration of these zones has presented a challenge to scientists for decades, it is considered necessary to investigate the unexplored trenches and their specialised microbial communities to understand how organisms function at extreme pressures and what role they play in the global carbon cycle.

The ‘Hades‘ project – Benthic diagenesis and microbiology of hadal trenches (ERC Advanced Grant), aims to provide the first detailed, combined analysis of benthic diagenesis and microbial ecology and diversity of some of the deepest oceanic trenches on Earth.

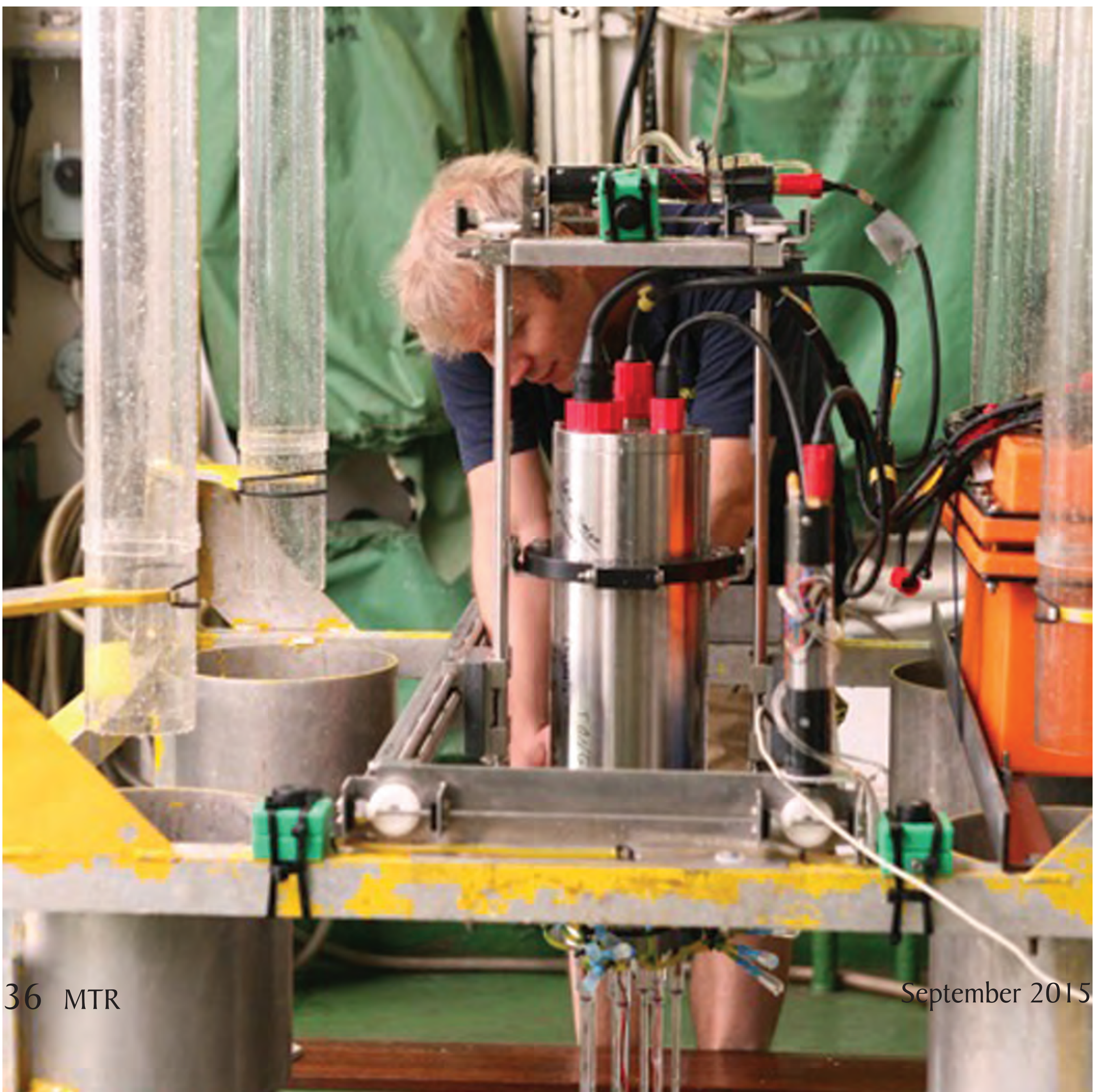
An international team of researchers, led by Prof Ronnie N Glud from University of Southern Denmark (DK), and including scientists from Max Planck Institute for Marine Micribiology (G), Scottish Association of Marine Sciences

(UK) and the University of Copenhagen (DK), will take the innovative step of studying and sampling deep-sea organisms in their own environment (in-situ). To achieve this, the Hades project requires two purpose-built robots, a profiling lander and sediment sampler (which will have two different modes), to operate at depths of up to 11 kilometres in cold, corrosive conditions, withstanding pressures reaching 1100 bar. Various components for the new robots are being produced around the world before finally being assembled at University of Southern Denmark.

Prof Ronnie Glud explains, "We argue that deep trenches, some of the most remote, extreme, and scantily explored habitats on Earth, are hotspots of deposition and mineralization of organic material. With the development of innovative, autonomous in situ instrumentation to overcome large sampling artifacts from decompression, we will i) determine rates of benthic metabolism and the importance of the deep trenches for the marine carbon and nitrogen cycle, ii) explore the unique benthic microbial communities driving these processes, and iii) investigate the proposed great role of virus in regulating microbial performance in hadal sediments."

Previous expeditions such as the Mariana Trench in 2010, have revealed surprisingly high levels of biological activity at nearly 11 kilometres deep. The Hades project now aims to investigate how life is sustained at these depths and how its activity affects the biogeochemical functioning of the oceans and the Earth.

In the Pacific Ocean, three trenches have been selected based on the different nutrient conditions in the overlying surface waters and different physical-oceanographic conditions, influ-



encing the volume of organic matter at each site: the Atacama Trench off Chile (max depth 8068 metres), the Japan Trench, south and east of Japan (max depth 9,504 metres) and the Kermadec Trench north of New Zealand (max depth 10,047 metres).

Sampling the Hadal Trenches

Each robot will be built to perform a particular task - one robot will be designed to quantify the oxygen uptake by the sediments. A second will investigate alternative anaerobic (i.e. oxygen free) processes that may be used by sediment organisms to convert the organic material (e.g., nitrate or sulfate for respiration). The third robot will be designed to collect sediment samples to be brought to the surface. This instrument will ensure the sampled microorganisms are fixed in-situ and can be retrieved without being modified during sample retrieval.

The sediment O_2 uptake, determined from concentration profiles, provides an excellent proxy for the turn-over of organic material in marine sediments. During a previous cruise, the team used a profiling lander consisting of an electronic cylinder housing, capable of carrying up to 11 micro-sensors (oxygen and resistivity). The electronic cylinder with the sensors was moved in steps of 100 - 250µm across the sediment-water interface into the seafloor, down to a depth of approximately 15 cm. After the vertical profile was finished, all sensors were moved back to the start position. The electronic cylinder was then moved horizontally and the vertical profiling started again. This procedure enables the measurement of >100 profiles along a 40-cm transect per deployment.

"We used a "Benthic Profiling Ultra-Lander System" to perform high-resolution oxygen concentration profiles down to a depth of 11,000m. The prototype has demonstrated proof of concept, but has also given us experience that needs to be implemented for a more reliable performance. This includes new designs of gearboxes, vertical and horizontal instrument sledges, pressure compensation units, as well as the integration of batteries, specially designed buoyancy and acoustic releasers." Said Glud.

The "Autonomous Sediment Sampler and Injection Ultra-Lander System" will be able to either collect sediment cores or to inject tracers and fixation fluids. The latter will be used to study process rates or to preserve active microbial cells directly at the seafloor. The instrument design will be based on the traditional dampened coring principle of multiple corers and an injection lander providing high quality samples that remain mechanically undisturbed and guaranties a safe recovery of the lander.

Dr. Frank Wenzhoefer, of Max Planck Institute for Marine Micribiology, Bremen (Germany) explains, "Four core liners will be driven into the sediment by individual motors. When the core liners are retrieved, core catchers seal the liners at the bottom. The new instrument is an essential "work-horse" that, cost efficiently, will provide sufficient, mechanically undisturbed hadal sediment samples. For in situ incubation or fixation of sediment samples, the core sampler will be additionally equipped with an injection module. This will enable injection of substrates or fixatives along a central vertical trace in each core. For incubations, the instrument will remain at the seafloor for a preprogrammed duration."

Using labeled substrates the system will be used for in situ quantification of transformations of nitrogen, sulfur and organic substrates, while also enabling the in situ injection of fixatives for subsequent microbial investigations and quantification.

The Engineering Challenges

Such lander systems have been used to water depths of 6000m, however the technical challenges and the fact that only 2% of the seafloor is below 6000m have, so far, limited scientists abilities

to work at such great depth.

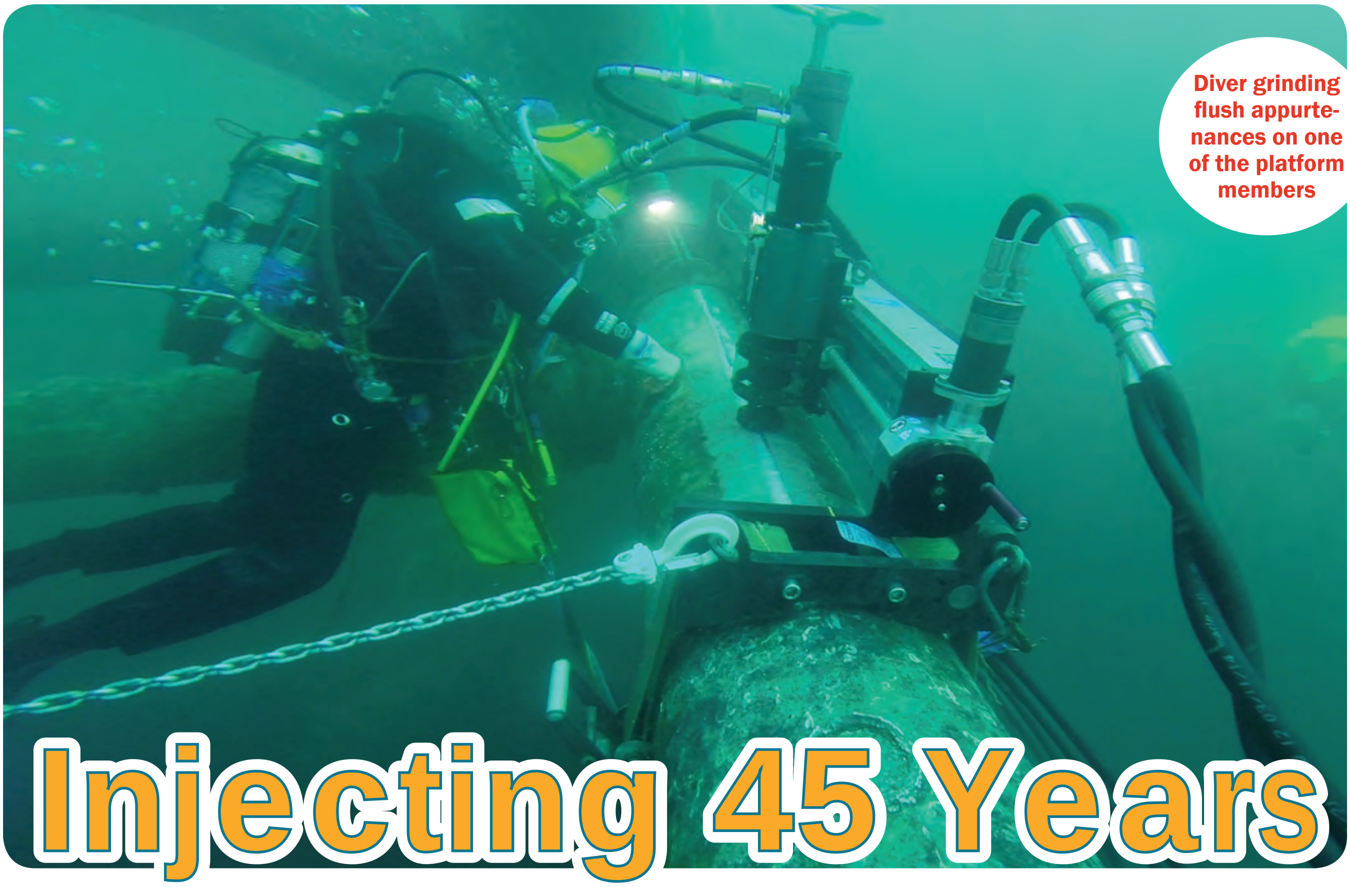
The high hydrostatic pressure, the corrosive environment and the fully autonomous operation of the systems are design issues engineers must face when building these systems. Electronics will require storage in pressure housing with high-pressure resistance connectors. Additionally, connectors for microsensors must have a high electrical impedance. Moving parts, like vertical and horizontal sledge systems, will also have to work properly at this high pressure as well as requiring all electrical and mechanical components to work autonomously.

"The most difficult aspect is the high hydrostatic pressure at which all components have to work and the fully autonomous operation of the systems - a proper

lander-software is needed to control the working steps during the deployment. Furthermore malfunction of the autonomous operation would only be recognized after the recovery of the system, thus after several days of deployment." Said Wenzhoefer, "However, such lander systems will help, among others like video and photo-landers, to explore one of the last unknown and challenging habitats on earth. These systems can be used for further studies of microbial ecology and biogeochemical processes at numerous deep sea locations."

By comparing trenches from contrasting oceanic settings the project provides a unique analysis of Hadal biogeochemistry and a deeper understanding of the role of deep trenches in the oceans, as well as fundamental new insights to the composition and functioning of microbial communities at extreme pressure.

Wenzhoefer explains, "The project is a great opportunity to enhance our knowledge on deep sea ecology and to explore so far unknown habitats of our planet. It is fascinating to deploy autonomous instruments at the deepest spots on earth and it is always an exciting event waiting for robots to surface, checking if everything worked properly and downloading the data or analyzing the samples. Within the new projects I am looking forward to discuss, design and operate new in situ technologies with our team of scientists, engineers and technicians all aiming for new ways to explore our planet."



Diver grinding flush appurtenances on one of the platform members

Injecting 45 Years of New Life

Divers installing new conductor guide frame

When the Dan Bravo Complex came on stream in 1972, the facility – Denmark's first producing offshore oil field – was expected to produce for 25 years.

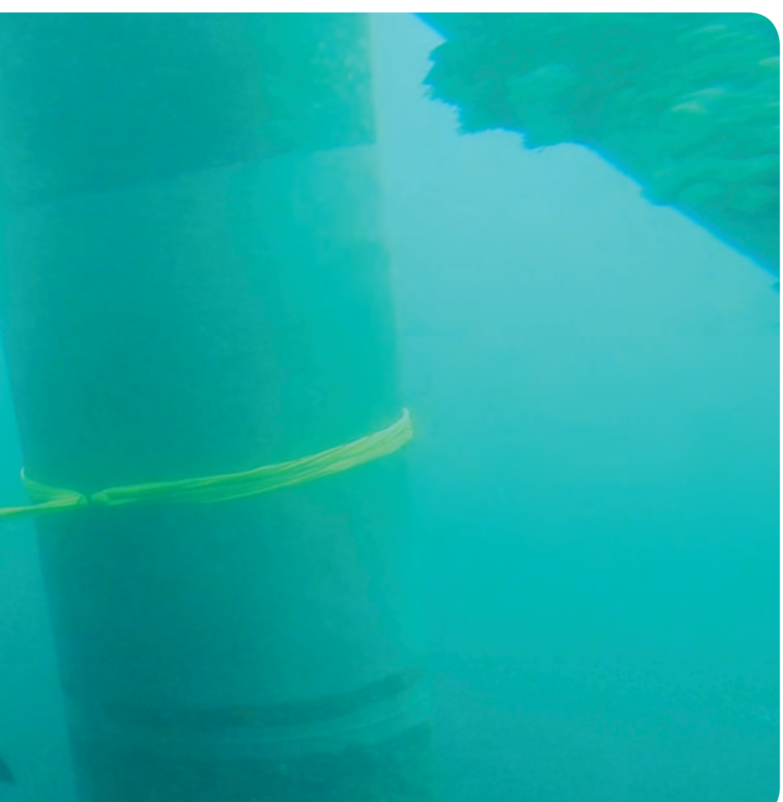
Now, thanks to a complex, multi-year subsea structural reinforcement campaign involving the installation of 136 tonnes of new steel, over more than 200 diving days, the life of the complex's wellhead platform, Dan A, is expected to be nearly trebled to total 70 years when the work is finalized.

The structural overhaul of the Dan A platform's jacket, undertaken by Dutch offshore contractor Boskalis, in close partnership with operator Maersk Oil, involved multiple firsts – beneath the waves.

The complex project, akin to a 3D, subsea puzzle, involved a large subsea photogrammetry campaign, site clean-up, preparation work and the installation of temporary cranes on vertical platform members to help maneuver the new steel into place at 10-41m water depth - all while the platform was in production.

The Subsea Services business unit of Boskalis, which was contracted for the installation, as well as fabrication, procurement, equipment testing and structural examinations, was also tasked with installing a new boat landing ladder on Dan B, and removing obsolete equipment from the Dan A and B as part of the Dan Bravo Rationalization (DABRAT) program.

"This had not been done before – fortifying underwater structures in this way on this scale," says Captain Bert Kamsteeg, contract manager, Maersk DABRAT, at Boskalis.



DSV Constructor working on site

Jakob Knudsen, DABRAT project manager, Maersk Oil, says: "Had nothing been done, the platform's life would have been shortened."

The Dan field was discovered in 1971, about 125 miles west of Esbjerg, Denmark. Dan A and C are wellhead platforms and Dan B is the process platform of the Dan Bravo Complex. These platforms were installed in the 1970s. The Dan Bravo complex had in fact been ordered from the US for the Kraka field, but it was installed on Dan when Dan was found to be larger.

Boskalis' involvement in the DABRAT project started early in 2013, with preparation work starting that February. The main scope was to reinforce Dan A's jacket, using 10 clamps, called K-node clamps, and to install a new conductor guide level – both of which would require carefully maneuvering 15 pieces of up to 4-5-tonne sections of fabricated steel through slots in the platform's structure, guided by divers.

The first challenge was mapping the existing structure, which, over the years, had been extended by assessing existing inspection data and acquiring new data. In July-September 2013, a huge photogrammetry exercise – the largest ever of its type - was carried out beneath the waves. Subsea, air and saturation divers first marked out the structure, using 3,000 magnetic, coded markers, and then some 20,000 high-definition, overlapping photographs were taken over a 70-day campaign. The photographs were then converted, using computer software, into an exact geometric 3D model, using the information from the markers, from which the K-nodes and conductor level guide could be designed

Next, inspection work, surface cleaning and preparation work had to be done, including underwater grit-blasting and measuring member wall thickness, prior to installation work, all while having to contend with some unfavorable weather conditions and sometimes reduced subsea visibility.

"In winter 2013/14, steel fabrication started in Denmark and an intense planning period, setting out preparation and procedures for execution, started, ahead of the big challenge - the installation work," says Kamsteeg. "Divers do not do this kind of work very often. A lot of risk assessment studies and training were done."

One of the challenges was how to transfer the steel from the ship to the position it needed to be in, beneath the platform, underwater. "The platform had a small 2.3-tonne capacity crane, but the steel weighed in subsea conditions in some cases 4-5-tonnes," says Kamsteeg. "One of the solutions, and actually the only sensible solution, was to build up two temporary cranes, 12m above sea level, on to the vertical members of the platform, something which has not been done before. This itself was a challenge, first having to install a clamp with a pedestal on to the vertical member, and then building up a conventional knuckle boom crane on to it - which itself first had to be dismantled into 2-3-tonne pieces in order for the platform crane to be able to lift them."

Two cranes Boskalis already had on vessels in its (offshore) fleet were used, and modified so they could be remote controlled from the dive support vessel (DSV), to avoid having to procure new cranes, avoiding any possible procurement delays.

Installing the temporary cranes meant steel could be lowered from one of the two DSVs used (the Protea and Constructor), then connected to the temporary platform crane's hoist wire, before being disconnected from the DSV's hook by divers and maneuvered into place assisted by divers subsea and rope access personnel at the platform.

The K-clamps were created to reinforce areas of the jacket structure where a horizontal member is intersected by cross members. Each clamp comprised of two sections to create a steel-to-steel friction clamp, which is held fast using steel bolts, weighing 10 kilos a piece. To install the 10 clamps, some 2,000 bolts were used, each having to be handled and set by the divers using specially-built hydraulic tensioning gear and a specially designed tool basket was used for handling the bolts and nuts subsea.

In connection with the maneuvering in and then installing the new conductor guide level the main section of the new level, measuring 3m-wide and 8m-long, needed to be lowered, tilted, and slotted through the platform members before being brought back on to the horizontal and lifted into place, before being bolted into place using further sections of steel.

This was all at about 13m below the surface, with more than a dozen "handshakes", switching hooks, switching from the DSV hoist to temporary crane and again to the temporary air hoists, switching hooks again. Co-ordination above and below the water line, between divers, rope-access workers and the dive supervisor, whose only vision link to what was happening in the water was via a camera on the diver's helmet and video from observation class remote operated vehicles (ROVs) was crucial.

"For our divers, that was the most challenging part of the project due to the volumes of steel involved, in different shapes and lengths," Kamsteeg says. "It was also the most time consuming part of the project - getting the steels into position.

"We knew we had to get it in position in between the six existing conductors. We had to fly it in vertically in between the two rows of conductors then flip it horizontally, and fit the out rigging to the vertical members of the platform. Then we had to lift it in to place fixate the bellmouths to the conductors and bolt it down. It had to be built up from all the pieces of steel to get it into place and in its proper shape to it would support the platform itself.

Maersk Oil Dan complex

"Everybody has to wait all the time for the other to be in position or ready. We had two divers in the water, who needed to be in the right position at the right time and they needed to have the right tools at the right time. It is almost like a computer game with various sensor inputs. In our contingency planning we expected to do it in two weather windows. We actually did it in one."

Once the new conductor guide level was installed, the old levels were removed. As part of its scope, Boskalis also replaced a number of anode bracelets, which also involved significant inspection, cleaning and preparation work, including removing marine growth, grit-blasting, and taking measurements.

The final part of the 2014 offshore campaign was removing the temporary cranes before the winter season.

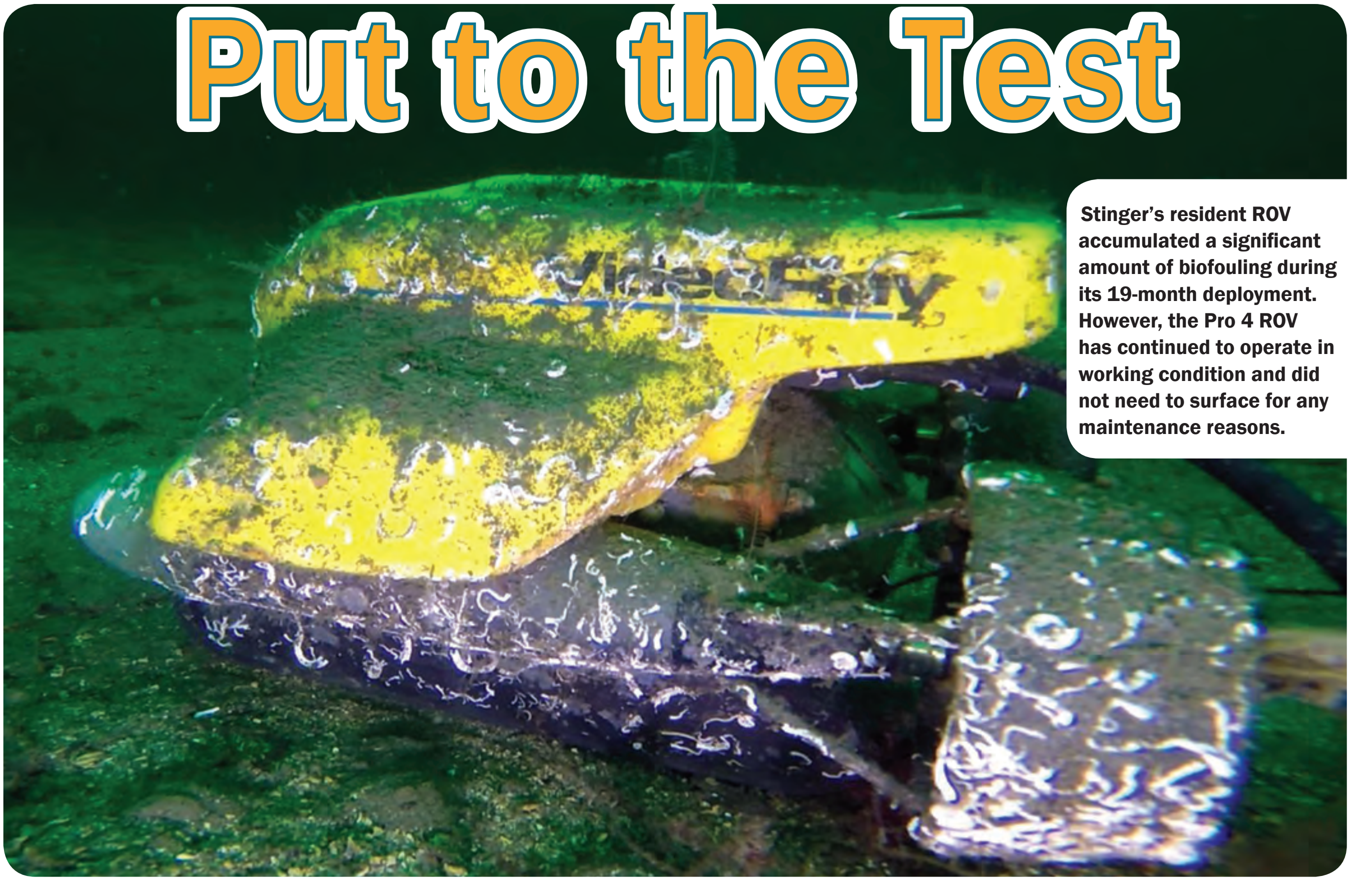
When the project is finalized the result is a comprehensive makeover of the facility below the water, says Knudsen. "The impact on Dan A, achieving a lifetime extension to 70 years in total, is quite an achievement."

The 2013-2014 campaign was also an HSE success. Over the 200-day offshore campaign, there were no lost time incidents, a testament to onshore planning, preparation and onshore rehearsal of many of the steps due to be undertaken offshore, says Kamsteeg.

“The planning and preparation was key,” adds Knudsen. “We did as much as we could onshore. Once you go offshore there’s a high cost involved, every minute is a lot of dollars. We have had more than 200 diving days over the last two years.”

The project has happened in close collaboration between the Subsea Services business unit of Boskalis, which set up an office in Esbjerg for the project, and Maersk Oil, including at least one face to face meeting each day. “The project couldn’t have been done without this close working relationship,” concludes Knudsen.

Put to the Test



Stinger's resident ROV accumulated a significant amount of biofouling during its 19-month deployment. However, the Pro 4 ROV has continued to operate in working condition and did not need to surface for any maintenance reasons.

(Photo Credit: Bjarte Langeland/Stinger)

VideoRay Pro 4 ROV: Surviving 19-Month Remote Wireless Deployment in the North Sea ROV First Deployed November 2013 as an Experimental Emergency Response System

While the maritime environment is generally regarded as one of the most harsh on earth, it could be argued that outside of the respective poles, the North Sea presents one of the harshest environments for all things maritime and subsea. With that as a backdrop, consider that a VideoRay Pro 4 Remotely Operated Vehicle (ROV) spent 19 months operating continuously in the North Sea, in what is believed to be the longest uninterrupted deployment of a single ROV of any class, according to the company

Put to the Test

The operation began in November 2013 as an experimental emergency preparedness solution for Stinger Technology AS, a subsea services provider for the offshore oil & gas sector. The Pro 4 "resident ROV" was deployed off the coast of Stavanger, Norway, but operated mainly from Stinger's offices which are located nearly 250 meters inland. The ROV remained powered on and in full operating condition for the entire duration of the deployment. Before Stinger voluntarily ended the ROV's deployment on May 20, 2015, the submersible had not surfaced for repairs or even routine maintenance.

"Originally, we anticipated it would last about three months," said Stinger CEO Bjarte Langeland. "But the Pro 4's endurance has obviously significantly outlasted any of our expectations."

The goal for Stinger's resident ROV project was to test the system's limits, determine the implications of long-term continuous use underwater, and ultimately to prove the Pro 4 ROV as an extended or resident emergency preparedness solution.

The resident ROV could begin an inspection immediately after being called into action, thanks to its "home" position on the seafloor. Having an on-call ROV system can significantly reduce the time and resources needed for an ROV operation, especially in emergency situations.

Stinger also wanted to test the use of a resident ROV to monitor methane gas buildup, which pose a threat to offshore oil & gas operations. If left undetected, gas buildups can cause explosions, resulting in costly and even fatal damages to wells, platforms and the environment. These buildups are especially of critical concern in Norway, where methane levels have risen drastically over the last 10 years due to melting permafrost and seepage from under the Arctic seafloor.

"While the ROV is a 'remotely operated' vehicle, standard operations require the pilot to stay fairly close to the system,"

(Photo Credit: Bjarte Langeland / Stinger)

This aerial shot shows the position of Stinger's resident VideoRay Pro 4 ROV system, which was deployed in the North Sea but operated mainly from Stinger's headquarters 250 metersaway.

said Langeland. "Our resident ROV project investigates how we can further remove the pilot from the physical ROV deployment, making it possible to involve multiple experts in real-time operations."

Remote Control

The resident ROV was mostly operated remotely over a WiFi network, instead of directly from the Pro 4 Integrated Control Box (ICB). All the standard Pro 4 equipment – submersible, ICB, and tether – was still deployed as usual, but the ROV could be piloted from locations other than the deployment site. This allowed Stinger to operate the Pro 4 from their headquarters immediately, rather than waiting until they could get a pilot onsite.

"Eliminating the need for the operator to be physically near the surface unit for our ROVs has been a long term goal at VideoRay" said Scott Bentley, VideoRay's founder and CEO. "Stinger's innovation here is extremely impressive, and we are proud to partner with them on this project."

Stinger has used VideoRay ROVs since 2010.

One of the biggest challenges of distance piloting operations is maintenance. Standard preventive maintenance practices and visual inspections require the ROV to be recovered in between operations so the pilot can identify any

(Photo Credit: Bjarte Langeland / Stinger)

Two of Stinger's VideoRay Pro 4 ROVs.

potential issues, conduct necessary repairs, and replace any damaged or consumable parts. In lieu of standard procedures, Stinger developed new methods of maintaining the system without surfacing. The resident ROV was housed in a crate on the seafloor, which helped reduce the amount of biofouling that the ROV might experience through natural wear and tear of being underwater. It also kept out any predators who may be too aggressively curious about its new neighbor in the North Sea. Every few days, a pilot "spun" the ROV's thrusters to dislodge any debris that may have settled since its last deployment. Stinger also used a second Pro 4 ROV to monitor and visually inspect the resident ROV on a regular basis.

Several standard Pro 4 features lend themselves well to the successful distance piloting of the resident ROV. The VideoRay Pro 4 Cockpit control software includes several health status monitors that detect and alert the pilot to any internal malfunctions, such as leaks, overheating, or lost communications. Cockpit also features an extensive interactive engine room where pilots can monitor the status of the thrusters, power supply and compass calibration. Other Cockpit features, such as auto-heading and auto-depth, dynamic compass and depth gauge, and tether turn counter, make it possible to keep track of the resident ROV's position at all times.

Although the ROV was always powered on, it was only in flight when needed. This helped conserve consumable parts, especially the cartridge seals which lubricate the thrusters.

Once the submersible was surfaced, Stinger completed a thorough evaluation of every component, from small screws

(Photo Credit: Bjarte Langeland / Stinger)

Screengrab from the Stinger live feed.

to internal electronics. Though they observed some surface growth, minor corrosion, and salt accumulation on some of the hardware, every piece was still in working condition after spending nearly 14,000 hours in the North Sea.

Although Stinger is the first VideoRay customer to use remote wireless deployment in a commercial context, VideoRay has been experimenting with this idea for more than a decade. VideoRay's first foray into remote wireless deployment was at the VideoRay International Partners Symposium (VIPS) in 2004 with a Pro 3 ROV using PC Pilot, the predecessors to the Pro 4 and VideoRay Cockpit. The ROV was deployed in Key Largo, Fla., but could be piloted in real-time over the Internet by operators from Exton, Pennsylvania – 1,250 miles away. Other examples of remote VideoRay piloting include the Mini Habitat Adventure program at Marine Lab in Key Largo, and a 2008 promotion for Foster's Beer in the United Kingdom where participants around the world could control the ROV from their own PCs

"The wireless piloting set-up we used in 2004 was nowhere near as sophisticated as the Stinger system," said Bentley. "However, the use of the PC Pilot control software instead of a built-in joystick did help determine the direction for our next generation of technology, the Pro 4. Similarly, Stinger's innovative approach to resident ROV installation and remote wireless piloting will help inform the next generation of our technology and open doors for the rest of our users as they find new ways to implement VideoRay technology for faster, safer, and more cost-efficient operations."

OTT Hydrometry & the

New Monitoring Network for Scottish Ports

Historically, ferry masters operating off the west coast of Scotland would have to sail to a port and on arrival visually assess the weather and tide conditions before deciding whether safe berthing alongside the pier or quayside would be possible. This wastes time and fuel, and can causes immense frustration among passengers, who may see ferries come close to a port, but thereafter depart without berthing when conditions are determined by the ferry Master to be unsafe.

With multiple sites in island locations, remote access to accurate local data providing live information on tide level and key climatic conditions could facilitate substantial improvements to the service by aiding the Masters to make a more informed decision at an earlier stage in the voyage – in some instances even before departing the previous port or harbor. The berthing of ferries is a highly skilled job, particularly during bad weather, and the decision on whether a specific ferry can safely berth at a specific port is subjective and ultimately can only be taken by the ferry Master.

Caledonian Maritime Assets Limited (CMAL), which owns many of the ferries, ports and harbors in the region, procured a network of 15 tide and weather stations from instrumentation specialist OTT Hydrometry. The new monitoring equipment provides live data on port conditions to enable the ferry sailing decisions to be made in a timely manner.

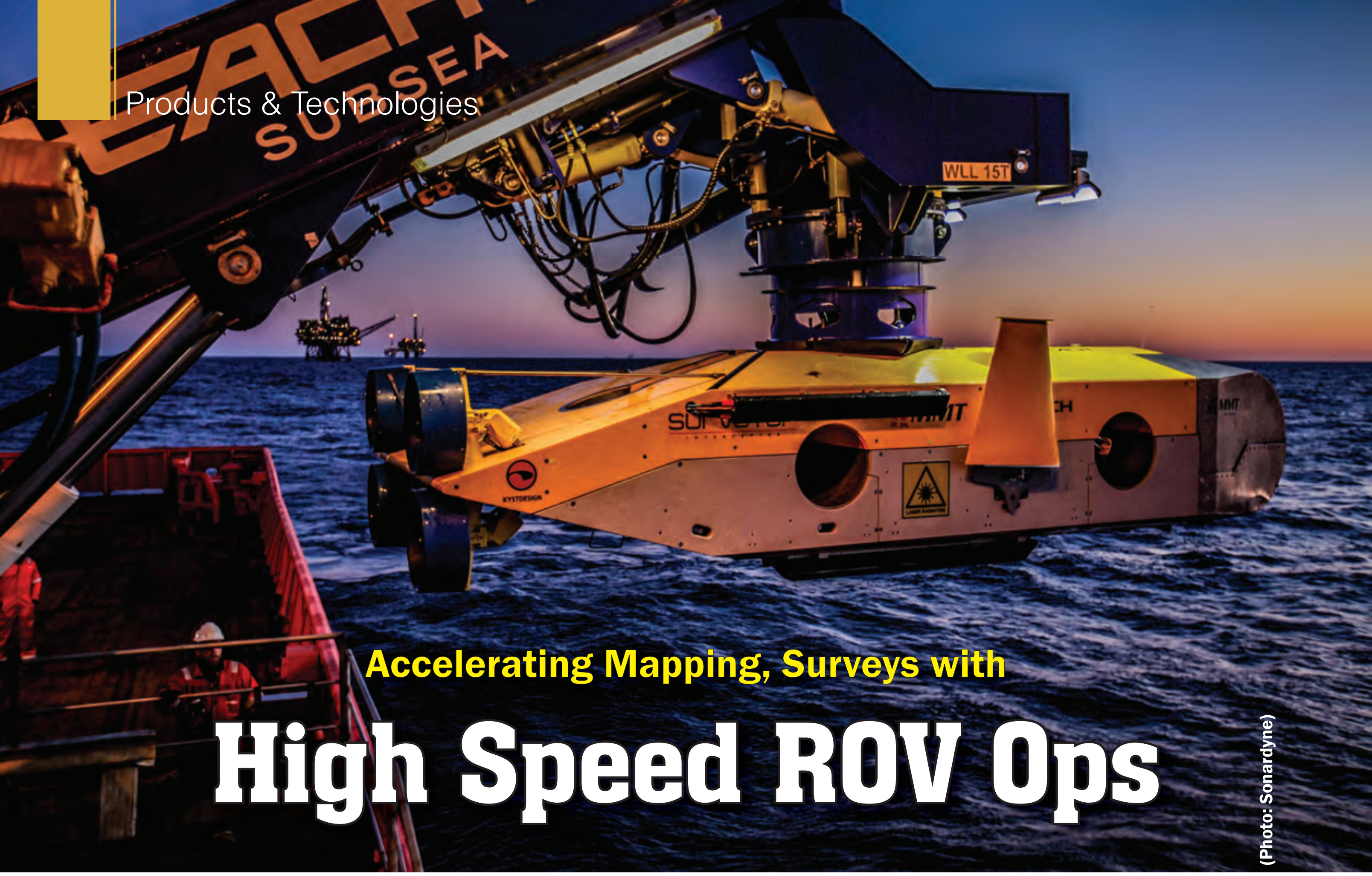
"OTT installed the first monitoring station in August 2014 and the network is now almost complete with sensors providing data every 1 minute via UHF radio to 'gateways' in the ferry offices, which then submit the data via the internet to a central server, which can be remotely accessed by authorized users," said CMAL Harbor Master David McHardie. "We have a regulatory requirement to monitor the tide level in our statutory harbors, but this system also provides essential weather information for our ports.

In the past, these measurements were taken manually, so the availability of continuous multiparameter data is an enormous improvement – not just in the quality and value of the information, but also in the safety benefits for harbour operations staff, that this provides."

The safety considerations involved with the berthing of ferries relates not just to passengers and crew but also to the pier hands that assist with mooring operations in a wide variety of often extreme weather conditions. "Mooring operations are inherently high risk activities; handling ropes can become extremely heavy when wet and subject to enormous forces when under strain," David says. "So, it is important for us to be able to assess the impact of wind, temperature and waves to protect harbor operations staff. Severe weather berthing conditions can also potentially cause damage to ferries and the structures within the ports, so again, detailed data on localized conditions can help prevent accidents and support insurance claims when necessary."

Emphasizing the growing need for data, McHardie said: "In recent years, severe weather events appear to have become more frequent and they seem to develop faster; for example, since the monitoring network was installed, we have recorded a sudden drop in temperature of 8°C in just five minutes at the port of Armadale on the Isle of Skye, and a maximum wind gust of 96 knots at Castlebay on the Isle of Barra. These conditions represent a rapid deterioration of conditions and the monitoring network enables us to respond quickly and effectively."

Each monitor is located adjacent to the main berthing area on the pier with a lockable GRP control box. The system is comprised of: an OTT radar level sensor; a Lüfft ultrasonic weather monitor measuring wind speed, gust and direction, air temperature and barometric pressure; an Adcon radio unit with back-up batteries and a marine grade antenna. The radar tide level sensor is an OTT RLS, a non-contact sensor employing pulse radar technology with a large 35m measurement range. Both the RLS and the weather sensors, which have no moving parts, have extremely low power consumption, which is vitally important for installations at remote sites. At two locations it was not possible to install a radar sensor so an OTT CBS (bubbler sensor) was installed providing comparable levels of accuracy and reliability.



Accelerating Mapping, Surveys with

High Speed ROV Ops

(Photo: Sonardyne)

MMT's Surveyor Interceptor ROV is equipped with Sonardyne's SPRINT INS system to improve the accuracy of high speed pipeline inspections and surveys.

MMT completed offshore integration trials of its new high-speed remotely operated vehicle (ROV) with Sonardyne International's SPRINT inertial navigation system.

The 2,000 meter rated vehicle, named Surveyor Interceptor, has been developed by MMT to improve the speed and efficiency of seabed mapping and pipeline inspections surveys. Its design features a hydrodynamic hull and powerful drivetrain enabling the vehicle to travel at up to six knots, around 50 percent faster than conventional Work-class ROVs. The accuracy of SPRINT complements the vehicle's state-of-the-art imaging and mapping sensors, resulting in improved survey data quality and reduced 'cost per kilometer' of surveys, the developer said.

Travelling at high speed close to the seabed requires the vehicle's automatic maneuvering and propulsion systems to be supplied with highly precise and uninterrupted position updates. To meet this requirement, MMT selected Sonardyne's acoustically aided inertial navigation system, SPRINT. Designed for subsea vehicles, SPRINT makes optimal use of acoustic aiding data including USBL, LBL and Doppler Velocity Log (DVL) and other sensors such as pressure sensors to improve accuracy, precision, reliability and integrity in any water depth.

Inertial navigation is inherently self-contained and robust with very good short term accuracy but can drift over time. SPRINT is therefore aided with complementary acoustic positioning data to provide long term accuracy and robustness and greater vehicle control.

On the Survey Interceptor, a Sonardyne Inverted Ultra-Short BaseLine (iUSBL) transceiver has been interfaced directly to the SPRINT resulting in a highly optimized navigation solution that delivered position updates up to 100 times a second.

The system architecture inside SPRINT has been developed with flexibility and expandability in mind, meaning that the same vehicle-mounted hardware can be used as a premium survey vehicle grade gyrocompass or an acoustically aided INS depending on operational requirements. Users are able to upgrade and switch capability on demand using remotely activated in-field upgrades, meaning they only pay for the features they need.

"When testing the new MMT Survey Interceptor ROV, we were looking for an inertial navigation solution that would deliver real-time performance with high speed updates," said Jonas Andersson, R&D Manager at MMT.

"By running Sonardyne's SPRINT inertial navigation system we witnessed a marked difference in the accuracy of all ROV positioning activities during the period, which in turn made a marked difference to the quality of the survey data received."

ASI Marine & its Mohican ROV perform

Deepest Tunnel Inspection

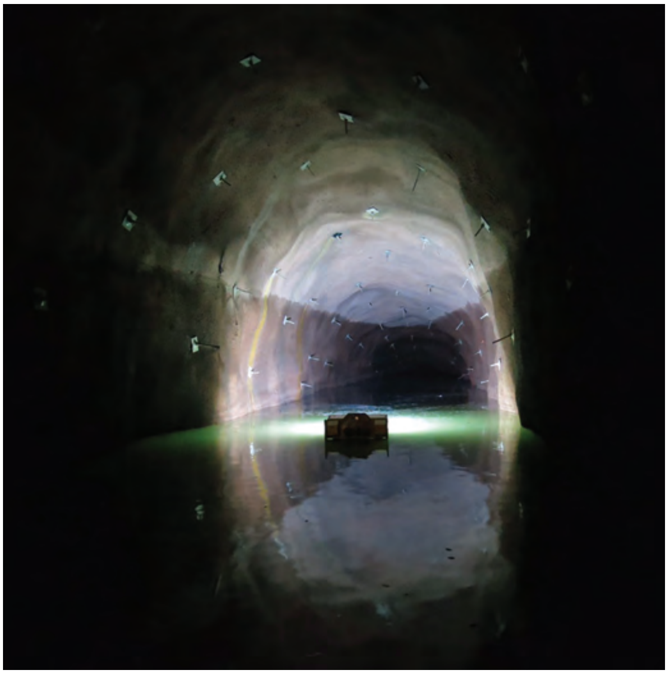
In June 2015, ASI Marine (ASI) personnel conducted a remotely operated vehicle (ROV) underwater inspection of the Cheves Hydropower Tunnel in Peru and ended up breaking the ASI company record for the deepest flooded tunnel inspection at 570 m water depth. The Cheves Hydropower Project is being developed by EMPRESA DE GENERACIÓN ELÉCTRICA CHEVES S.A., a wholly owned subsidiary of Statkraft.

The tunnel inspected is approximately 9.8 km in length, with a 35 sq. m. area horseshoe profile. The purpose of the inspection was to collect data inside the newly-constructed tunnel for general assessment of rock stress incidences.

The tunnel was inspected internally with a Remotely Operated Vehicle (ROV) equipped with an array of sensors, including sonar and video, with the purpose of collecting full coverage data at the headworks and downstream to the powerhouse. The ROV was specifically designed by ASI for this type of work and is unique in the world. This data was required for the client to undertake an engineering structural assessment of the tunnel and detect significant anomalies; such as deformations, major cracks, rubble, partial collapses and rock accumulations.

Within a short period of two weeks, and with very limited preparation time, ASI responded to the client's request, mobilizing internationally to the remote location. To perform the inspection, ASI utilized its ASI Mohican ROV, which afforded ASI a quick response time. This system was specially designed by ASI for tunnel inspections and is controlled and powered from the surface, which allows the ROV to navigate through tunnels for unlimited periods of time.

In 1999, ASI obtained (and still holds) the record in the Guinness Book of World Records for the "longest flooded tunnel survey by an ROV" at a different location.



(Images: ASI)

A Rendering of the Kraken Active Towfish, KATFISH-180, including the 180 cm sonar array.

(Image: Kraken)

Kraken debuts New Sonar Platform

Katfish

Kraken Sonar introduces KATFISH (Kraken Active Tow FISH), a sonar platform for military and commercial applications which the company sees as a key development objective in delivering on the company's "sensor-to-systems" strategy. Kraken said the primary objective of the KATFISH project is to develop an actively controlled, intelligent towfish as a platform for real-time ultra-high resolution seabed mapping system, based on the company's Miniature Interferometric Synthetic Aperture Sonar (MINSAS) technology and Real-Time SAS Processing algorithms.

The KATFISH system is comprised of an actively controlled smart towfish, winch and handling subsystem and operator console. The winch and handling subsystem provides the capability to launch, tow, recover and stow the tow fish. The entire system is designed to be quickly installed and removed from craft of opportunity platforms and is packaged for easy transportation.

While conventional side scan systems are limited in that they only provide high resolution imagery at short range, KATFISH produces ultra-high resolution seabed imagery with constant resolution to full range, Kraken said. The additional information provided by KATFISH delivers a detection and classification capability that cannot be achieved with a conventional sidescan sonar.

KATFISH is also designed to generate highly accurate bathymetry data that's co-registered and geo-referenced to the same pixel grid coordinates as the imagery. Operators can produce crisp seabed imagery and detailed 3D digital terrain maps of seafloor topography that exceed IHO SP-44 survey standards.

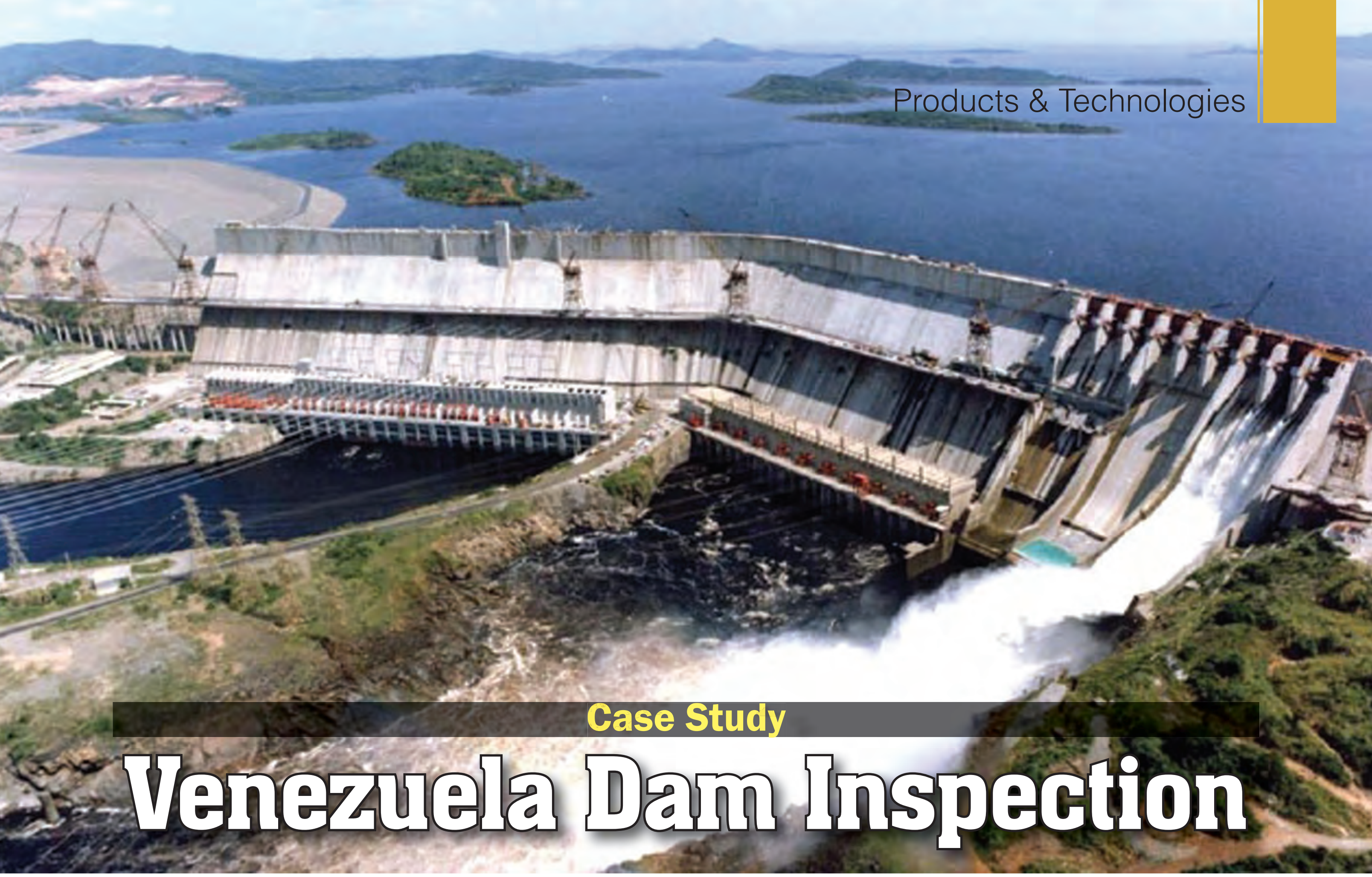
The capability of generating centimeter-scale resolution in 3D also provides significant performance improvements in the detection, classification and identification of small seabed objects.

The KATFISH system also implements a SAS gap filler transmitter that produces high resolution data in the nadir region. The system uses two rows of identical receiver elements to deliver bathymetry. An additional lower frequency transmit element, unique to KATFISH, provides a SAS resolution gap fill directly under the platform.

Sonar data is transferred from the transceiver to the processing unit via a Gigabit Ethernet network interface. The sonar operation is controlled from a graphical user interface (GUI) on a notebook computer. The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by Kraken's INSIGHT application software.

KATFISH is currently under development and has completed proof-of-concept sea trials. The system is now being commercialized with a series of technical milestones planned for 2015. Commercial availability is scheduled for 1Q 2016. Budgetary pricing for a complete turn-key system is expected to be in the range of $1.5 million.

www.krakensonar.com



Case Study

Venezuela Dam Inspection

For inspection of its vast Guri Dam and associated turbines, the Venezuelan Government has chosen a Saab Seaeye Falcon ROV fitted with a special survey system. Built in the 1960s and one of the largest reservoirs on earth, work is underway to extend the life of the dam by 30 years. Work in the hydro industry is not unusual for the Falcon ROV, as a Falcon was modified to swim five km through a tunnel in Canada; a Falcon fitted with a full sonar system on a retractable device was used to inspect inlets and outlets, grids and tunnels at a major Italian dam; a Falcon was sent to inspect 96 km of tunnels under the city of Buenos Aires; and a Falcon was employed to help position a 75-ton inlet structure to mm accuracy at a lake in Nevada, U.S.

For a detailed survey of the infrastructure at Guri Dam, authorities have chosen to fit a sonar and navigation system on their Falcon formulated by California-based underwater systems supplier Symphotic TII Corporation along with MB Services in Miami that incorporates an Imagenex 881A-GS sonar with an Applied Acoustic's Easytrak positional location system.

Explaining the concept, Jack Roberts at Symphotic describes how, by combining both systems on board the Falcon, scanned images remain stable while the ROV swims around in any rotation.

"This particular set-up has never before been adopted for a Falcon and has the added advantage of being simple to integrate in the field at the kind of remote location found at a hydro installation."

He describes how the multi-frequency programmable sonar makes it easier for the operator by providing a more stable view of the environment, while the ultra short baseline positioning system readily allows the vehicle to return to points of particular interest. Also, by fitting the Falcon with a Lyyn real-time video enhancement system that self-optimizes the image at 25 times a second, clearer pictures can be captured than would otherwise be possible.

Project Report

Companies involved in the project

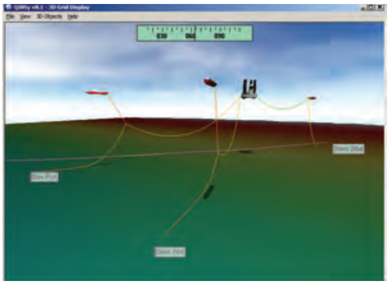
Saab Seaeye
Symphotic TII
MB Services
Imagenex
Applied Acoustics
Lynn

Above: Guri Dam, Venezuela, one of the largest reservoirs on Earth.

Left: The capable, adoptable Falcon.

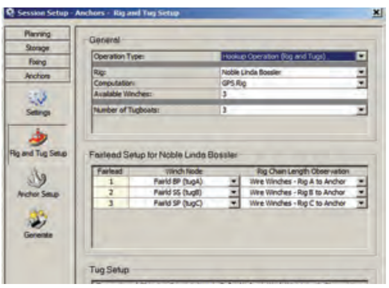
(Photos: Saab Seaeye)

QINSy



Software design company Quality Positioning Services BV (QPS) has upgraded its hydrographic data acquisition, navigation and processing software package QINSy (Quality Integrated Navigation System). The latest version, 8.10.2015.06.29.1, includes a new feature called Hook-Up Operations for Anchor Handling, for pre-laid anchors powered by Orcaflex of Orcina.Traditional anchor handling, including showing the catenary, was already possible with QINSy. The anchors are run from the rig or barge using tug boats that deploy the anchors at the planned positions. During the anchor handling procedure the catenary, powered by Orcaflex, is shown during the entire operation. With the new Hook-Up procedure the anchors are already pre-laid on the seabed, but not yet connected to a rig or tug boat. The anchor has a wire with a (sub) surface buoy at the end. QPS said the advantage of using Orcaflex for the catenary calc is it supports complex anchor wires that consist of different types of material, which all have their own structural characteristics.

www.qps.nl



Kraken Wins Sonar Contract from ECA

Kraken Sonar won a contract valued at more than $325,000 by ECA Robotics to supply and help integrate its AquaPix Miniature Interferometric Synthetic Aperture Sonar and Embedded Real-Time SAS Signal Processor on ECA Robotics' newest A18D autonomous underwater vehicle (AUV). Kraken describes its AquaPix as a sonar system providing military grade technology that provides 3D seabed imaging, faster data processing and a lower cost. AquaPix is designed for operation on AUVs, manned and unmanned surface vessels and towed bodies. The modular system uses the latest electronics, transducer arrays and signal processing software optimized for the demanding size, weight, power and cost constraints of unmanned maritime vehicles. AquaPix generates bathymetry data (25cm along-track x 25cm across-track x 5cm height) co-registered and geo-referenced to the same pixel grid co-ordinates as the imagery. Operators can produce crisp seabed imagery and detailed 3D digital terrain maps of seafloor topography that exceed IHO SP-44 survey standards.

www.krakensonar.com

Katfish

OceanGate and Battelle combined undersea tech to explore the GOM's Flower Garden Banks. When OceanGate's Cyclops 1 dove deep into the Flower Garden Banks National Marine Sanctuary, it did so with an extra set of all-seeing eyes. Mounted to the five-man submersible was the Battelle HorizonVue, a video camera that provides real-time, live video with a 360-degree view. Intended for use by Work Class ROV operators, and the subsea oil and gas industries, the HorizonVue camera provides enhanced situational awareness in areas where keeping track of multiple objects simultaneously is critical.

The HorizonVue camera and software records all 360 degrees of the scene simultaneously. When the video is played back the user is able to use a digital pan and tilt window to explore the 360 image in an immersive environment to investigate what is missed by the array of cameras normally used.

www.battelle.org

(Photo: Battelle)

Shark Marine

Shark Marine Technologies announced the integration of the Ebinger 725K Underwater Metal Detector with its own Navigator diver-held imaging sonar and navigation system. This integration provides the diver with another underwater tool whose collected data can now be completely geo-referenced to the location of the diver using it. Sensory data from the metal detector is recorded to the Navigators internal solid-state hard-drive where Shark Marine's Divelog software correlates it to the position data from the systems multiple navigation sensors. The data is provided to the diver both graphically and audibly. Integration with the Navigator also allows the diver to take advantage of the system's additional features such as the multi-beam imaging sonar which provides visual target detection capabilities and guidance even through murky waters.

www.sharkmarine.com

Fugro Expands Survey Services, Satellite Imagery Capabilities

Fugro has extended its integrated survey services through an agreement with global specialist EOMAP that enables the creation of integrated bathymetric survey products that comprise elements from Satellite Derived Bathymetry (SDB), Airborne LiDAR Bathymetry (ALB) and traditional acoustic survey technologies. "Teaming with EOMAP augments our considerable survey and satellite imagery capabilities and will allow a timely and cost-effective nearshore bathymetry review facility for clients whose own bathymetric holdings are either very old or very sparse - or both," said Don Ventura, Hydrographic Business Development Manager at Fugro. "This service will help coastal zone management and engineering teams, environmental scientists and hydrographic agencies to focus on their immediate needs and to make more informed decisions on subsequent, efficient data acquisition and management."

EOMAP's technology platform can process satellite images and deliver global bathymetric and benthic habitat data over the full range of temporal and spatial resolutions through its proprietary, sensor-independent Modular Inversion Processor (MIP). This both complements and augments services already provided by Fugro, to provide even more spatial data solutions to suit a wide variety of budgets and purposes.

www.fugro.com

EIVA NaviSuite

EIVA has launched a NaviSuite eLearning site, which via an annual subscription aims to offers users training modules covering various aspects of the NaviSuite features and applications that they can access regardless of the time of the day and where they are in the world.

According to EIVA, the site will see continuous development in the coming months and years with additional modules being added to the site, based on input from the users. Thereby, users can expand and update NaviSuite skills on an ongoing basis, as a supplement to EIVA's classroom training courses in the NaviPac, NaviScan, NaviEdit, NaviModel and NaviPlot solutions. A personal login allows users to track and document learning progress and achievements.

When the library of eLearning modules reaches a level matching the content of EIVA's current classroom training courses, the latter will be redefined to focus on specialist courses, EIVA said. NaviSuite users will be able to achieve an understanding of the NaviSuite products via the eLearning site alone, which then will be expanded with dedicated, in-depth specialist classroom training courses.

All EIVA classroom training course participants in 2013, 2014 and 2015, as well as everyone who signs up before December 31, will get a discount.

www.eiva.com

The Sustainable Ocean Summit 2015

November 9-11, 2015, Singapore

By Paul Holthus, founding CEO of the World Ocean Council

"Sustainable development" has gone from buzz word to business imperative in the two decades since the initial Earth Summit in Rio de Janeiro in 1992. Companies are increasingly evaluated on how well they address sustainability as a critical measure of their commitment to the triple bottom line – people, planet and profit.

Stakeholders expect companies to develop sustainability and corporate responsibility programs and reporting as part of efforts to take up civil society concerns and maintain the social license to operate. The world's governments are poised to endorse a set of Sustainable Development Goals (SDGs) at a UN Summit in New York in September 2015. These SDGs are intended to define the aspirations and targets to guide governments, society - and business - for the next 15 years. One of the SDGs specifically focused on the ocean, with targets to address use levels, planning impacts and environmental protection. Many of the other SDGs have goals with significant implications for businesses worldwide, including the maritime industries.

To all this, the ocean business community can now add a new term - the "Blue Economy" - that that you will be hearing more and more. Broadly speaking, the Blue Economy is being defined as:

> *A sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy.*

What does all this mean for the people and companies providing ocean goods and services are fundamental to the future of the ocean?

The future of the ocean health and the concept of a Blue Economy are inextricably intertwined with the more fundamental, long-standing and ongoing reality of the ocean economy – the broad range of commercial activity undertaken for centuries by a diverse ocean business community that provides society with the ocean-related goods and services it demands.

This ocean economy depends on millions of people around the world who work on, under and around the sea every day to bring us ocean goods and services to support humanity. These men and women know the ocean better than most everyone else on the planet and care about the ocean that their kids and grandkids will inherit. Although much of the vast and diverse ocean economy is "out of sight and out of mind" for most, the people, companies and their activities that make up the ocean economy are the essential starting point and long term basis for any consideration of ocean sustainable development and a Blue Economy.

What is this ocean economy?

It is an estimated $4-10 trillion dollars/year in economic activity, including:

- 90% of international trade through cost- and carbon-efficient delivery via 50,000+ merchant ships crisscrossing the globe;
- Healthy protein from fisheries, from about 1.3 million fishing vessels, and from fish farms, with aquaculture growing 7% per year the past decades and now producing 50% of seafood;
- Growing offshore energy sources that supply about 30% of hydrocarbons, a rapidly increasing amount wind energy, and major wave and current energy potential;
- 98% of international telecommunications, carried on more than one million km of submarine cables;
- Recreation and tourism options for every ocean interest, with cruise tourism growing at 8.5 % per year in recent decades;
- Desalinated seawater to live in our booming coastal cities, with desalination supplying 90% of the freshwater in some countries;
- Innovation and technology to discover and document the deepest darkest corners, furthest reaches and extreme conditions of planet ocean;
- Ports and coastal infrastructure that all countries depend on for trade and growth; and
- Much else that sustains our modern life, booming population and growing expectations.

However, our use of ocean space and resources is affecting ocean health and sustainability. These effects of sea-based activities are also accompanied by often much more significant land-based sources of impacts, such as municipal wastes, agricultural runoff and plastics.

Ocean industries operate in a fluid, three-dimensional, interconnected ocean. This means industry's activities, responsbilities, and impacts are also interconnected – as must be industry sustainable developmnet efforts. The best efforts by a single company or even a whole industry sector will not be enough to secure ocean health and productivity into the future.

This creates a compelling business case for industry leadership and collaboration in tackling ocean sustainability, stewardship and science. Fortunately, there are many good, smart people in good, smart companies who do their best to understand and address ocean sustainable development. These leadership companies conduct their business in a manner that is compatible with the balanced environmental and economic needs of the communities in which they operate.

To further enhance responsible operations throughout different ocean industry sectors, a group of companies banded together to form the World Ocean Council (WOC) – the international, multi-industry business leadership alliance for "Corporate Ocean Responsibility". This collaboration helps identify sustainability risks, gaps and practical cross-sectoral, science-based solutions.

Cross-sectoral WOC teams are putting this unique industry alliance to work on a range of topics, such as ocean policy and

governance; marine spatial planning/ocean zoning; invasive species; marine debris/port reception facilities; marine sound; and improved ocean data collection. Robust data-sets, peer-reviewed published science, risk assessments, and use of the best available technologies are essential to these efforts.

An increasing number and range of ocean industry companies from around the world are distinguishing themselves as leaders in “Corporate Ocean Responsibility” by joining the WOC and are collaborating to achieve the “Blue Economy” - a balance of responsible ocean use and sustained ocean health.

(© Silke Stuckenbrock/Silke Photo 2008/Marine Photobank.)

How does all this relate to the future of the ocean? What are the projections for ocean industry activity in the coming decades? What opportunities and risks will future ocean use create for each sector, for the collective ocean business community, for the ocean economy overall, and for the ocean itself?

The diverse ocean business community will gather in Singapore (9-11 November 2015) at the 3rd WOC Sustainable Ocean Summit (SOS) to tackle these fundamental questions with a focus on “Sustainable Development and Growing the Blue Economy - the Next 50 Years.”

The SOS 2015 theme recognizes the contribution of the ocean economy to the food, energy, transport, communications and other needs of society and the role of the ocean business community over the next 50 years in:

- Ensuring the health, productivity and sustainable development of the ocean.
- Advancing responsible ocean economic activity that contributes income, jobs, goods and services in support of societal needs.
- Addressing how ocean industries can advance their leadership, collaboration and commitment to sustaining the interconnected ocean environment, people and economy.
- Planning for the next 50 years of Blue Growth, sustainable ocean economic development and responsible ocean business opportunities.
- Determining how ocean industries relate to the UN Sustainable Development Goals (SDGs).

The “Ocean + 50” plenary at the SOS 2015 will in particular be an unprecedented look into the future of ocean use around the world and across the sectors. Expert presentations will cover shipping, oil and gas, fisheries, aquaculture, renewable energy, cruise tourism, marine mining and submarine cables in this first-ever comprehensive platform on the future of ocean industries. The session will address the trends, geographies, assumptions, opportunities, and risks for each sector over the coming 50 years. The session will focus especially on 2015-2030, the time frame for the Sustainable Development Goals (SDGs) soon to be adopted by the U.N.

SOS

The Sustainable Ocean Summit (SOS) is the only global, multi-sectoral platform for leadership companies and organizations to advance the development and implementation of industry-driven solutions to ocean sustainability challenges. With Singapore celebrating its 50th anniversary in 2015 and continuing to advance its significant role in the global maritime economy, SOS 2015 will bring together the diverse ocean business community to plan for the next 50 years of Blue Growth, a sustainable ocean economy and responsible ocean business opportunities.

www.oceancouncil.org/site/summit_2015/

EDITORIAL CALENDAR

Month/Edition	Features		Bonus Distribution
January/February Underwater Vehicle Annual: ROV, AUV & UUVs Ad Close: 01/21	Market: Technical: Product: Special Report:	HD Cameras and Sonar for Vehicles Underwater Navigation Scientific Deck Machinery US Navy	
MTR Special Reports: Oceanographic February 2016 Bonus Electronic Edition			Publication Date: February 27, 2016
March Oceanographic Instrumentation: Measurement, Process & Analysis Ad Close: 02/22	Market: Technical: Product:	Subsea Engineering: Complexity of Subsea Field Architecture Oceanology International 2016 Technology Spotlight Sonar Systems & Seafloor Mapping	Oceanology International March 15-17, London Subsea Tieback March 22-24, San Antonio
April Offshore Energy Annual Ad Close: 03/21	Market: Technical: Product:	Seismic Vessels: Streamers & Magnetometers Deepwater Positioning, Mooring & Anchoring Subsea Vehicles and Systems for Pipeline Survey & Inspection	AUVSI May 2-5, Arlington OTC May 2-5, Houston
May Underwater Defense Ad Close: 04/21	Market: Technical: Product:	Offshore Renewable Energy: Wind, Wave & Tide International Naval Technologies Subsea Housings	Sea-Air-Space May 16-18, National Harbor Mast Europe May 24-26, Amsterdam UDT June 1-3, Oslo
June Hydrographic Survey Ad Close: 05/20	Market: Technical: Product:	Comms, Telemetry & Data Processing GPS, Gyro Compasses & MEMS Motion Tracking Interconnect: Underwater Cables & Connectors	
MTR Special Reports: Hydrographic July 2016 Bonus Electronic Edition			Publication Date: July 15, 2016
July/ August MTR 100 Ad Close: 07/22	The 11th Annual Listing of 100 Leading Subsea Companies Market:	 The Norwegian Subsea Market	Offshore North Sea August 29-September 1 Oslo
September Ocean Observation: Gliders, Buoys & Sub-Surface Networks Ad Close: 08/22	Market: Technical: Product:	Research Vessels Seafloor Engineering & Remote Operations Geospatial Software Systems for Hydrography	Oceans 2016 September 18-22, Monterrey
October AUV Operations Ad Close: 09/21	Market: Technical: Product:	Harsh Environment Systems for Arctic Ops ROV Technology: Workclass to Micro Systems Underwater Tools & Manipulators	Arctic Technology Conference October 24-26, St. John's
November/ December Subsea Engineering & Construction Ad Close: 11/23	Market: Technical: Product:	Fresh Water Monitoring & Sensors Offshore Inspection, Maintenance & Repair (IMR) Underwater Imaging: Lights, Cameras & Sonars	Underwater Intervention 2017
MTR Special Reports: Unmanned Marine & Subsea Vehicles November 2016 Bonus Electronic Edition Publication Date: November 7, 2016			

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