MARINE TECHNOLOGY REPORTER

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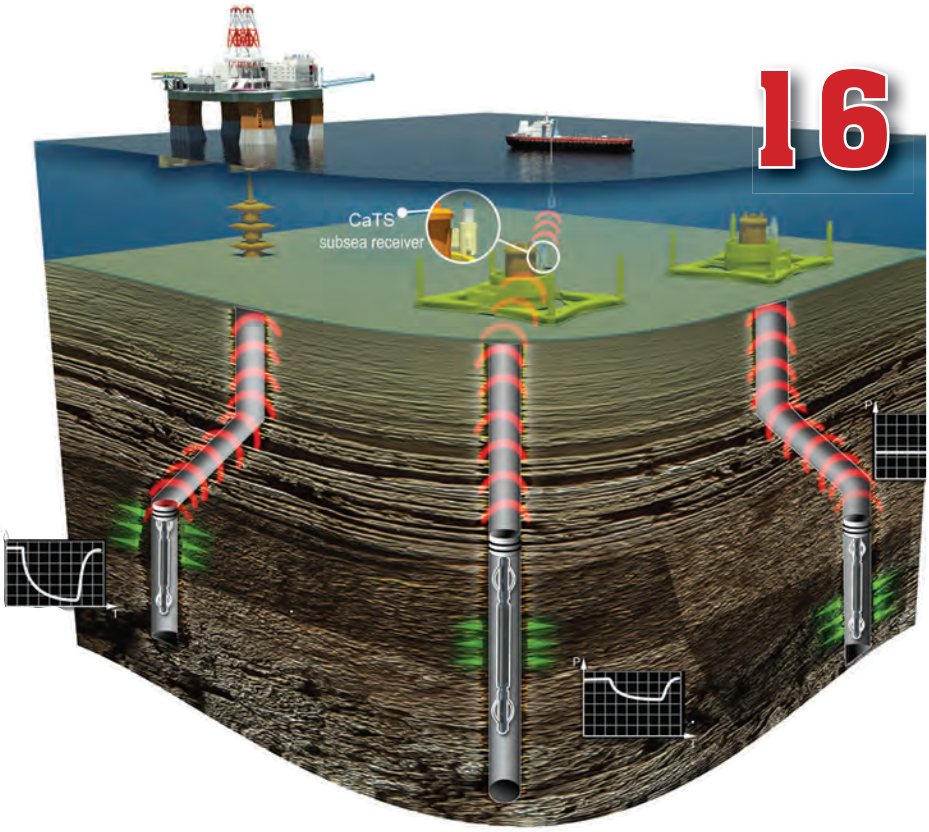

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(Photo: Denny Cornelissen)

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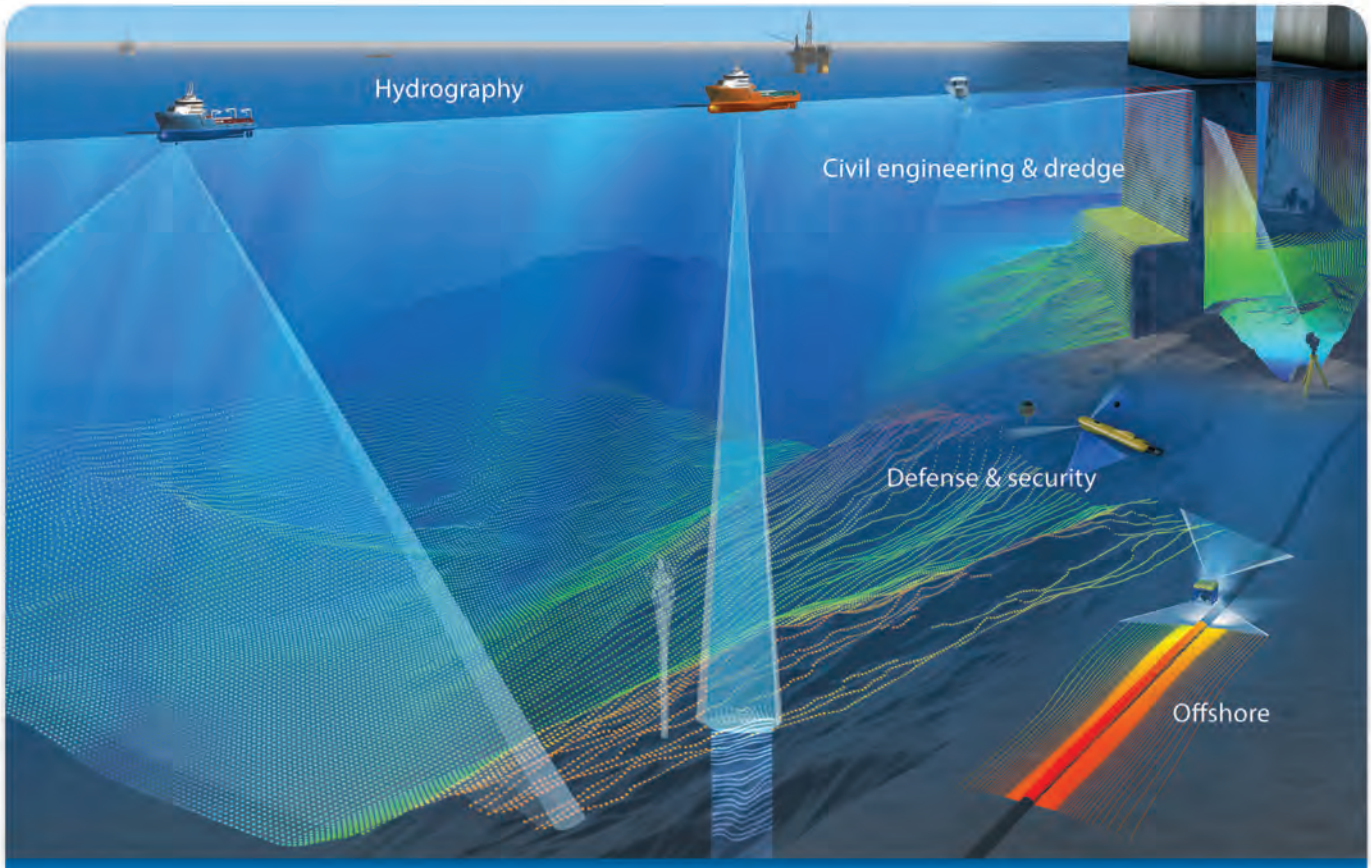

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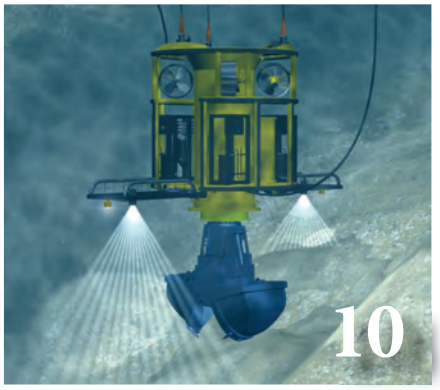
MEGA DREDGING PROJECTS



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Edward Lundquist is a retired naval officer who writes on naval, maritime, defense and security issues. He is a regular contributor to Maritime Reporter and MTR. *p. 14*

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*

Brian Champion

Brian Champion has a BSc in Geology and Physics and over 35 years of experience in field-management and technical positions in cased-hole logging and intervention. *p. 16*

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Earlier this month I was in Oslo for Nor-Shipping, certainly not an event related to this industry directly, but interesting nonetheless. The Norwegian offshore oil fields have certainly inspired and spawned generations of new subsea equipment, and the oil industry is central the Norwegian economy as a whole. While I know the Norway has been hit particularly hard by this year-long oil price drought, I was pleasantly surprised to see that overall the mood was better than expected, all things considered.

This month starting on page 24 we are pleased to present a fresh take on the oil price collapse and its effects on Subsea Hardware spending, courtesy of Ben Wilby of Douglas Westwood. The article is based on a recent DW report of the same topic, and while Wilby contends that growth is indeed stagnant overall, there are pockets of opportunity, as always.

Contributing author **Kira Coley** delivers insightful features as always, but this time twice in the same edition. Our cover story, starting on page 32, focuses on some exciting work within the engineering halls of MIT that is designed to offer AUVs more cognitive capabilities, enabling the systems to form their own mission plan with minimal input from humans. A shorter feature from Coley kicks off our "Tech File" section starting on page 10, documenting Van Oord's development of a new deep excavation system ... designed to dredging deeper and cheaper!

Staying on the dredging theme, we were happy to work with the International Association of Dredging Companies (IADC) in The Netherlands to present our Mega Dredging Projects feature starting on page 48. Here you will find the latest data and statistics regarding the health, direction and drivers of global dredging. But the real fun is the ensuing pages which documents in pictures and words five of the largest dredging projects in history, which is an excerpt from the IADC's new limited edition book, *Beyond Sand and Sea*, which celebrates 50 years of dredging.

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Seatronics Names Middleton MD

Seatronics Ltd., an Acteon company and part of its survey, monitoring and data business, promoted Phil Middleton from deputy managing director to group managing director. Middleton will be responsible for managing and developing Seatronics' global business with a particular focus on long-term growth, strategy and compliance. Middleton holds an honors degree in electronic and electrical engineering from Robert Gordon University.

(Photo: Seatronics)

Middleton

Polarcus Revenues Down

Polarcus Limited released its first quarter 2015 financial statements, reporting revenues of $81.1 million, down 33% from same quarter the previous year. The company's gross cost of sales were $68.7 million, down 13% from same quarter the previous year. Polarcus reported improved liquidity position by $59 million following an amendment agreement with the banks, as well as an extension of maturity of the $125 million convertible bond by two years to 2018. Rod Starr, Polarcus' CEO, said, **"The current market environment can be best described as uncertain,** as oil companies have continued to reduce or defer spending commitments making for a highly competitive landscape.

(Photo: Polarcus)

Starr

In response, we have stayed true to the 2015 Agenda I announced in February; building backlog, reducing costs, and managing our balance sheet. This focus included the difficult yet necessary decision to cold stack Polarcus Nadia at the end of the quarter.

"Our Agenda is starting to deliver. Backlog visibility has grown to 70% for the year, costs are down 13% from first quarter 2014, and we have secured important amendments to our Fleet Back Facility and pushed back the date for our next bond maturity to 2018.

We also recorded multi-client sales in the quarter of $36.7 million as our Capreolus 3D project offshore Australia passed the 50% completion milestone. All positive developments underpinned by continued safe and efficient operational performance in the field," Starr continued.

FORCE Preps for Turbines, Expands Team

With 10 km of power cables installed in the Bay of Fundy, a new environmental monitoring program in development, and turbines set for deployment in the near future, the Fundy Ocean Research Center for Energy (FORCE) announced new board and staff support. FORCE welcomes Joe Fitzharris as the chair of the board of directors. Fitzharris is Quality Manager at AMEC Black and McDonald, and has previously held senior management positions at Marener Group of Companies and Irving Shipbuilding. Joe has previously served as an independent director at FORCE, and chair of the Maritimes Energy Association.

Former chair John Woods continues as a FORCE board director, leading Minas Energy's tidal project.

FORCE also announced new directors Jeremy Poste, Director for Cape Sharp Tidal and Country Manager for OpenHydro Technology Canada, Johnny Watson, project manager of Atlantis Resources, and Sue Molloy, general manager of Black Rock Tidal Power. The FORCE board is comprised of nine directors: four developers, three independent directors, one academic, and the province, which includes Anna Redden, Director, Acadia Centre for Estuarine Research, Acadia University; Janet MacMillan, Partner, National Public Relations; Paul Jamer, President, Breakwater Group; and Sandra Farwell, Manager Director, Sustainable & Renewable Energy, Nova Scotia Department of Energy.

FORCE announced Mary McPhee has been promoted to facility manager at the FORCE site.

Subsea power cable being installed at FORCE.

(Photo: FORCE)

JMS Hires Manley

Justin Manley has joined Juliet Marine Systems (JMS) as Vice President of Business Development and Marketing. Manley brings more than 20 years of experience in the marine technology sector including roles at Massachusetts Institute of Technology (MIT) and with the National Oceanic and Atmospheric Administration (NOAA).

James Fisher Buys X-Subsea

Photo: James Fisher

James Fisher and Sons plc purchased the assets and intellectual property rights of X-Subsea UK Holdings Limited (X-Subsea) for a total consideration of $22.8 million. Headquartered in Aberdeen, X-Subsea went into administration on April 27, 2015 following the collapse of its Norwegian parent company Reef Subsea AS. X-Subsea was an operator of specialized excavation, trenching and dredging equipment, which was rented and operated worldwide for subsea operations in the oil and gas, telecoms and renewable energy sectors. It was the main competitor of James Fisher Mass Flow Excavation Ltd, operating from bases in Aberdeen, Dubai, Singapore, and the Gulf of Mexico.

Delta SubSea Secures New Build Olympic Delta

Delta SubSea, LLC has entered into an agreement with Olympic Shipping AS for the Olympic Delta, a newly built multipurpose subsea support and construction vessel. The Olympic Delta is a GREEN Vessel designed according to

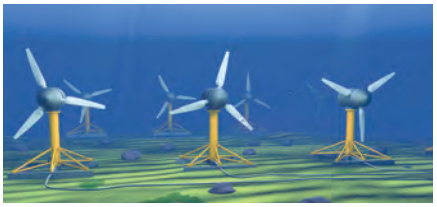
Image: Delta SubSea

DNV class, with high focus on reduced fuel consumption, which also means lesser emission to the environment. The vessel is equipped with two Delta SubSea Schilling HD 150 HP work-class remotely operated vehicles (ROVs) from DSS's fleet. The 94 m Olympic Delta has a maximum speed of 13 knots and is equipped with an 80 T (AHC) crane with 2,000 m of wire. The vessel also comes equipped with three bow thrusters designed for working in high currents and a 6 x 6 m moon pool for construction work. The Olympic Delta has one ROV hangerdeck area and two WROV LARS located on the starboard and port sides of the vessel. The vessel is equipped with Kongsberg K-Master DP control and navigation equipment and has 52 staterooms for 80-man POB.

BV Publishes Current & Tidal Turbines Guidelines

Bureau Veritas (BV) has published a set of guidelines, NI 603, intended to help the development of current and tidal turbines. The guidelines are backed by a separate guide to certification for marine renewable energy devices including tidal turbines, wave energy converters and ocean thermal energy conversion.

NI 603 Current and Tidal Turbines



sets down guidelines applicable to current and tidal turbines which are installed on the seabed and which produce electricity from tidal power, underwater current power or estuary water power. They cover the materials and loads for the support structure, including foundations and turbine and also the requirements for the electrical installation. There are sections on life-cycle considerations, manufacturing, installation, commissioning, maintenance and decommissioning.

Van Oord Develops *Deep Excavation System*

By Kira Coley

Stretching across oceans and continents, approximately 32,000km of new pipelines are constructed each year forming an industry worth $28 billion. The installation of pipelines on the seabed require engineers to develop innovative technologies and methods to inspect, repair and maintain pipelines at depths sometimes reaching 1000 meters. The Deep Excavation System (DES) is a new, cost-saving technique designed for dredging at great water depths for use in the offshore pipeline industry.

For new laid pipelines, large changes in seabed height can create free spans which can lead to stresses in the pipe. For decades, Subsea Rock Installation (SRI) has been the traditional approach for seabed preparation where dips and hollows are filled with crushed rock (installed by Fall Pipe Vessels) to support the pipeline and avoid these free spans. For the stabilization and protection of offshore pipelines, cables and other installations, SRI is a vital process for these subsea industries. While rock installation is a proven technique, new methods and innovative technology are still needed to reduce costs, especially as the industry moves deeper into the marine environment.

Developed by engineers at Van Oord, the Deep Excavation System (DES) combines the use of a clamshell for the

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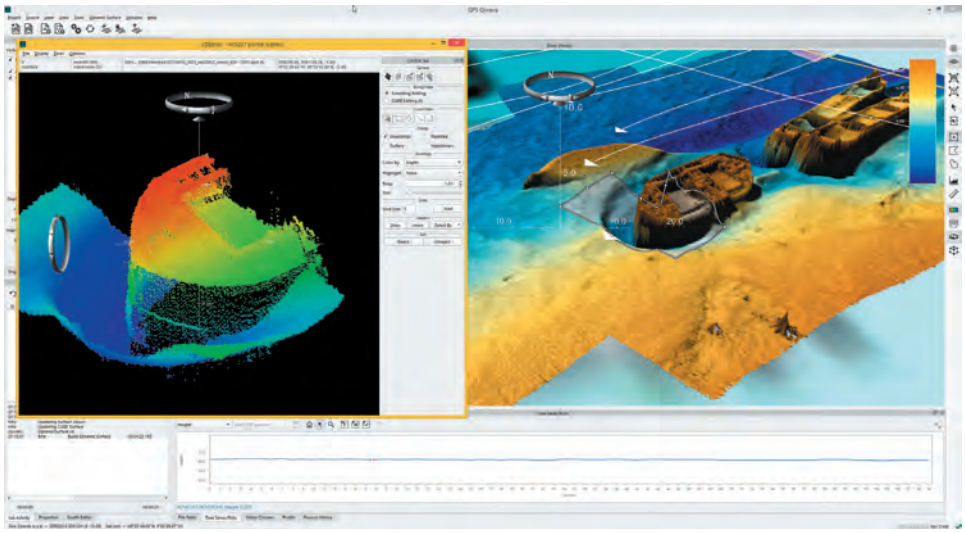

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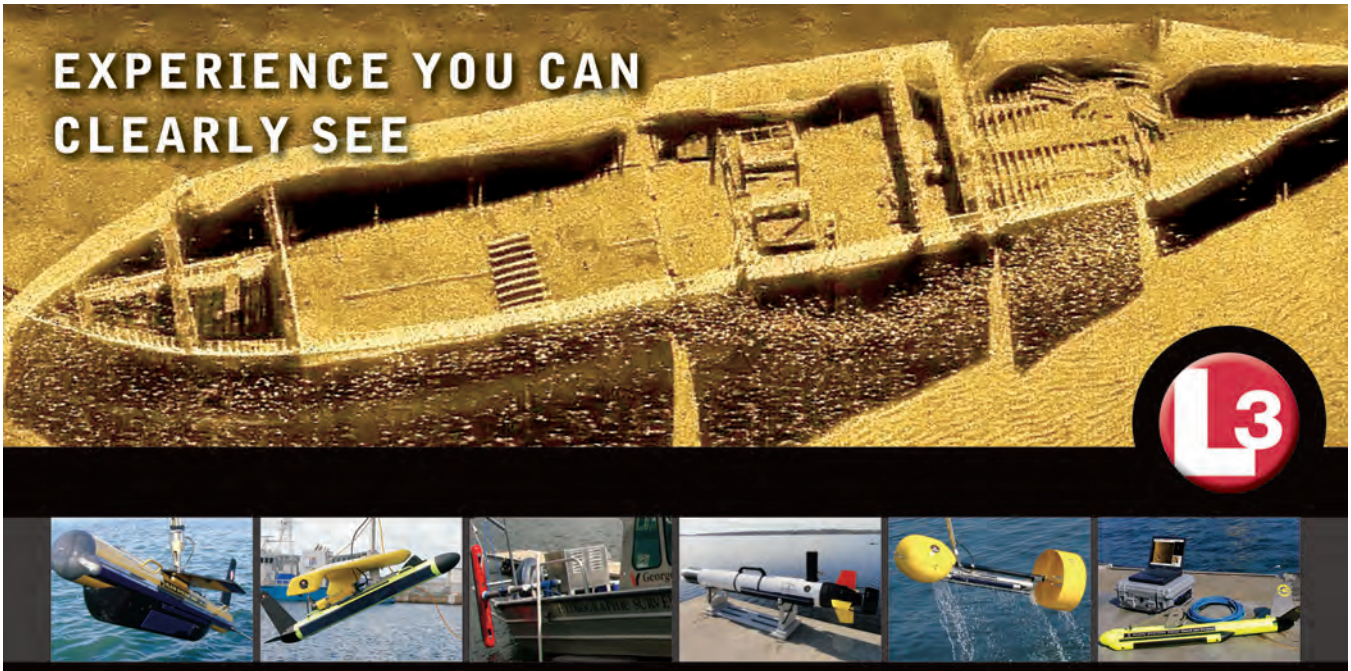

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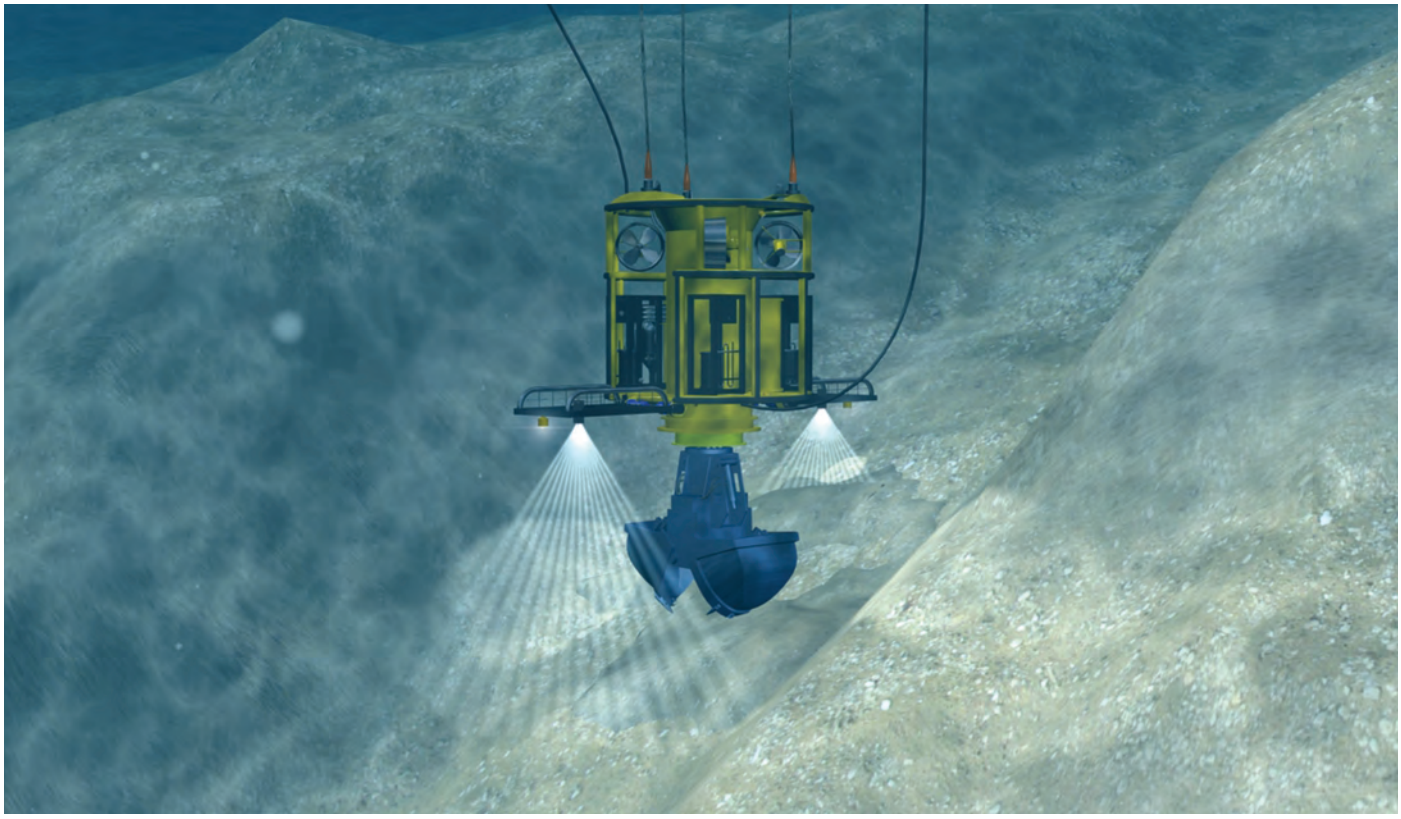

excavation of the soil, and the Fall Pipe Remotely Operated Vehicle (FPROV) for positioning and operation. The DES has a very accurate position control system and generates only very limited turbidity while allowing dredging to take place at depths varying from 100 to at least 1,000 m. Van Oord's flexible fall pipe vessels Stornes and Bravenes (operational in 2016) can be equipped with this system, which has been developed in-house.

"The most important benefit is the cost reduction in preparation of the seabed prior to pipeline installation to avoid unacceptable free spans. Another benefit for the environment is that DES does create very little turbidity. This is extremely important when there is coral present in the area. In addition, this system easily removes harder soils (as shown on a project executed in Australia in 2011)," explains Jan Vlak, Operations Manager SRI at Van Oord Offshore. "Excavating several thousand cubic meters of hard and soft soil can make the installation of hundreds of thousand tons of rock unnecessary, saving time and cost for offshore operators during these vital preparation stages."

As a market leader in the SRI industry, with more than four decades of experience, Van Oord's fleet of DP flexible fallpipe vessels and side stone dumping vessels enables Van Oord to provide pre-pipelay and post-pipelay rock installation, scour protection, seabed improvement and ballasting services for offshore structures at depths up to 1,500 m.

Robert de Bruin, Head of the department Communications and Markets and Spokesman of Van Oord said, "We have a deep-rooted passion for water and technology and a focus on performance and production. Our Marine ingenuity is the foundation of our success. We specialize in projects requiring a pioneer mindset, vision, impassioned commitment and innovative solutions. We continuously modernize our fleet, equipment and technology to meet our clients' needs. The DES is an example of this."


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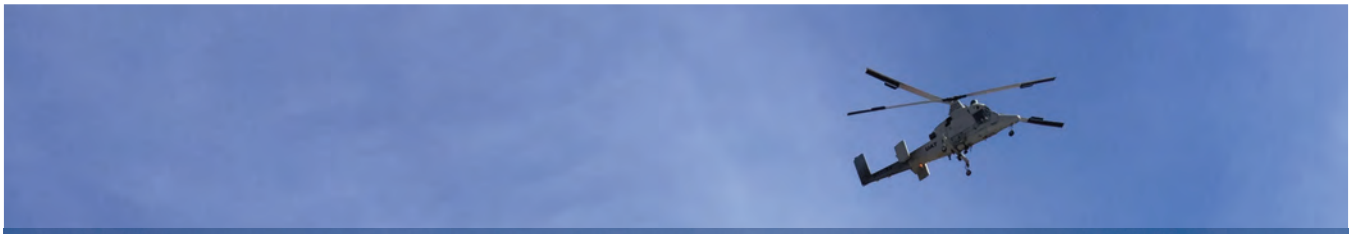


Unmanned Systems *Work Together* from Single Controller

By Edward Lundquist

Images: Neya System

Unmanned air and ground systems work together from single controller in flight demo; UCS architecture enables collaboration between big and small business.

A flight demonstration using a handheld tablet has shown how unmanned air and ground vehicles can be supervised together by a single operator, and how big and small businesses can work together. The demonstration was conducted on March 26, 2014, at Kaman Aerospace in Bloomfield, Conn., involving a Kaman K-MAX helicopter equipped with Lockheed Martin's mission management system operating in the unmanned mode, and a Neya Systems UxInterceptor unmanned all-terrain vehicle. During the medical casualty response and resupply scenario, the two vehicles were given instructions by a single operator using a VTOL Evacuation and Resupply Tactical Interface (VERTI) Medic Interface and UxFleet / Collaborative Mission Planning system from Neya Systems.

The flight test showed how the UCS Architecture can integrate a handheld ground control station with the aircraft and ground vehicle and enable collaborative activities between multiple autonomous platforms.

Neya Systems, a small business located in Wexford, Pa., near Pittsburg, developed the rapid prototype and demonstration effort leveraging several different small business innovation research (SBIR) grants and follow-on DoD funding. The company was partnered with the Lockheed Martin and Kaman team to deliver the innovative technology to existing systems.

The UCS architecture enabled the seamless integration of the K-MAX helicopter with the Lockheed Martin UCS-compliant ground control station; the UxInterceptor UGV and the Neya VERTI android tablet. Using the UCS-compliant VERTI system, there was no redesign of the UAS or UGV system required.

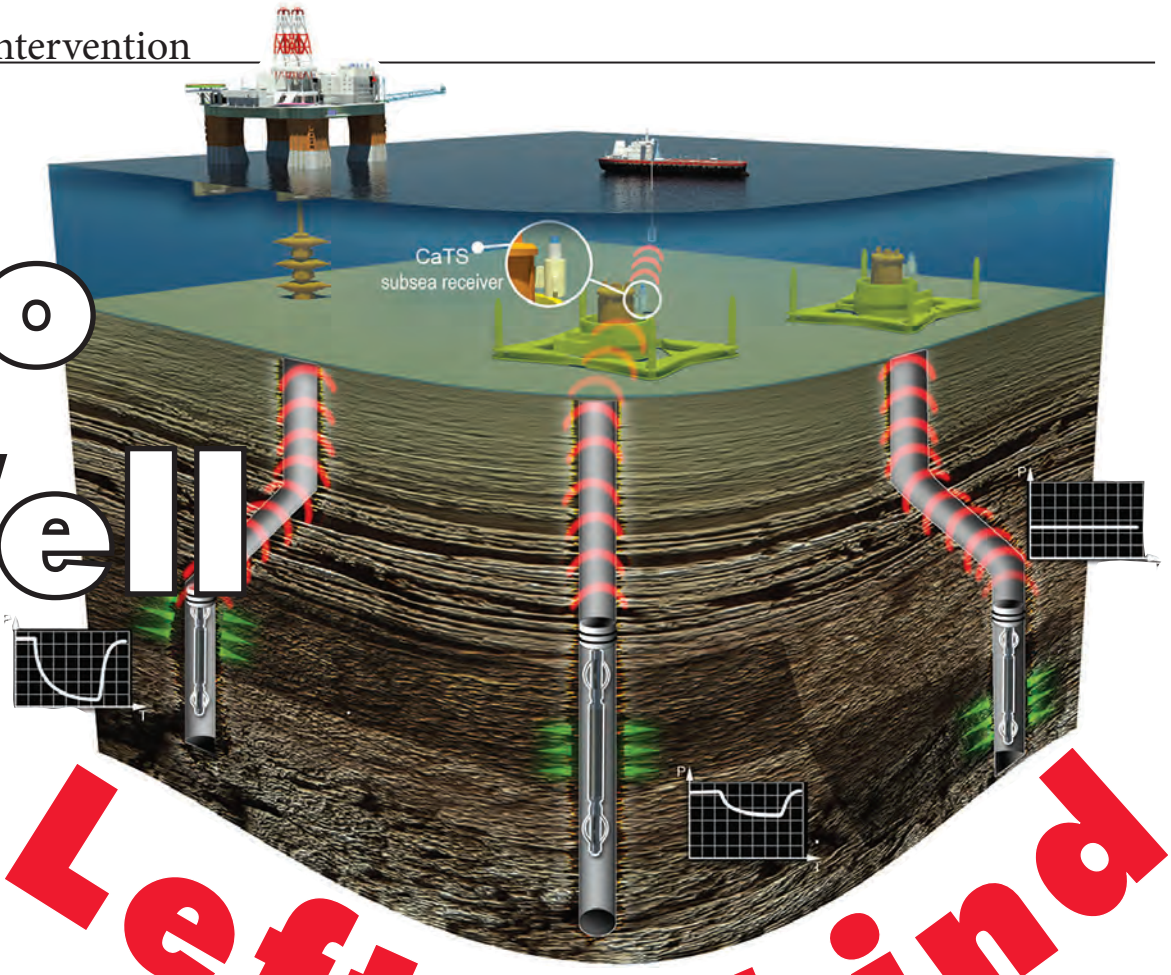
The user interface on the tablet is simple to use. The operator conducting the demo had no previous experience controlling unmanned systems and was able to control both the UAV and UGV at the same time after just one hour of familiarization training.

Images to the left:

Dave Martin of Neya Systems uses an Android tablet to control both an unmanned aircraft and ground vehicle at the same time.

The K-MAX helicopter, seen here with the unmanned UxInterceptor vehicle, can be operated in the manned or unmanned mode, and can lift 6,000 lbs.

No Well Left Behind



Reducing reservoir and well uncertainty via wireless intervention is one large step toward the "wireless reservoir"

By Brian Champion

Not knowing how connected or compartmentalized a reservoir is when evaluating appraisal or development drilling is a major concern. So, too, is well integrity.

Having a better understanding of reservoir connectivity can provide significant benefits in determining the most effective drainage and field-development plans.

One route to reducing uncertainty is to maximize time spent appraising the prospect. While multi-well interference and long-term pressure testing provide valuable data on connected volumes, there is always time-cost pressure to curb testing time, especially in the high-cost, deep-water subsea environment.

As a result, well testing operations may be terminated early, before there has been sufficient time for the "pressure-transient response" —monitored during a pressure buildup period — to adequately investigate distant boundaries. This can mean that critical decisions regarding future field development plans are taken based on limited or insufficient data sets.

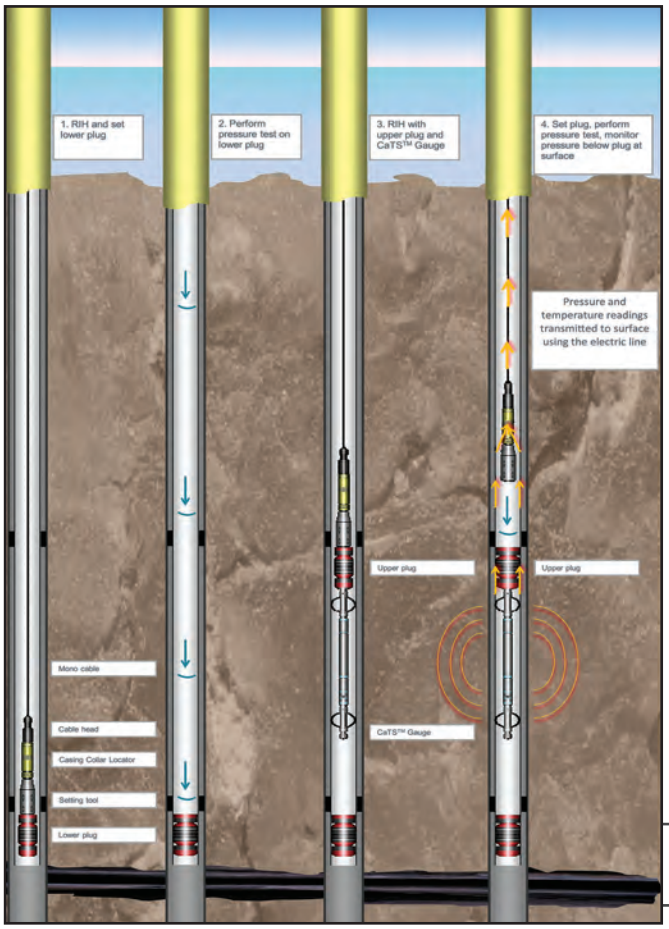
There is also an increasing industry focus on the development and application of new technology for well integrity monitoring. Examples include the long-term monitoring of the pressure in multiple annuli (the spaces either side of drill casing) in subsea production wells and the verification of pressure barriers during well suspension or plug and abandonment (P&A).

Wireless can be deployed to address of these concerns. Reservoir and well integrity monitoring are about preventing the offshore industry's most serious reverses.

Extended Reservoir Monitoring

Via the application of wireless, well testing no longer has to end at well abandonment. Advanced reservoir testing now enables abandoned wells, zones or pilot holes to be monitored for extended periods beyond final well abandonment.

Post-abandonment reservoir pressure data is being used by operators to monitor for connectivity with adjacent assets that are either being produced or injected into, and to collect long term pressure buildup data to investigate far reservoir boundaries and establish connected volumes. This is proving to be highly valuable information that would not be detected during the course of a typical 48-hour or 72-hour pressure buildup performed during a drill stem test (DST). In either case, high-value reservoir data is being collected over long monitoring periods and at low incremental well cost. In Cableless Telemetry Technology, or CaTS, that pressure data is transmitted wirelessly using a digital signal that provides reassurance no loss of fidelity will occur in the transmission's data. Each gauge has its own address, so multiple discrete (well/reservoir) zones can be monitored. Twenty zones have been instrumented successfully in a single well comprising stacked reservoir sands. The pressure/temperature data transmitted from downhole is stored at the seabed in a battery powered subsea receiver rated for water depths of 10,000 feet. The data is the collected from the receiver by a supply vessel passing overhead the abandoned well location and uploading the data from the receiver using wireless through-seawater communications. Once installed in an abandoned subsea well, there is no requirement to reenter the well using a semi-sub rig. The only remaining abandonment liability is to sever and recover the wellhead at a convenient time in the future, typically by workboat.



Better Well Safety

Based on electromagnetic (EM) communications technology, CaTS can also be flexibly located in any annulus and the pressure and temperature data can be wirelessly transmitted to a seabed receiver without requiring any wellhead penetration.

In terms of barrier verification, the NORSOK Standard D-010 covering well integrity in drilling and well operations requires that a plug is verified to the maximum differential pressure at the time of barrier placement. CaTS communications technology is unaffected by bridge or cement plugs, making it ideally suited to short-term and long-term well integrity monitoring.

During workover or P&A (plugging) operations it is common

Barrier check:
Wireless systems check annulus safety.

Easy access:
Platform supply vessel collects wireless well data.

Photo: Farstad

to install both deep and shallow set bridge plugs as temporary barriers at an early stage of the operation. In some wells it can be necessary to establish these two barriers deep in the well and relatively close together. The sealing integrity of the lower plug can generally be validated by pressuring from the surface and monitoring for any leakage using a surface pressure gauge. When installing the upper plug, and due to the relatively small volume of fluid between the two plugs, it is unlikely that a pressure test applied from surface will detect leakage past the upper plug. So, results might be inconclusive when using surface measurements to verify the upper plug.

By installing a wireless transmitting pressure gauge below the upper plug, it is now possible to monitor the pressure below the plug in real time at the surface during pressure testing. Monitoring requires no other equipment in the logging string used to deploy the plug and can be completed during the run of a downhole operation. Well abandonment barrier verifications have been completed from light-well intervention vessels on 13 subsea wells in Norwegian and British sectors of the North Sea.

Direct Network

CaTS transmits high-quality pressure and temperature information from reservoir to seabed using the well's tubing, casing or liner as transmission medium. Signals also transmit from seabed to reservoir for the control of downhole hardware like flow control devices.

Under favorable well conditions, this wireless technology has achieved point-to-point transmission ranges in excess of 12,500 feet without relay or booster stations in the well. By cutting the number of in-well equipment, deployment time and monitoring costs are lower.

Using standard completion components means there is no requirement for special high cost plugs or packers with penetrations. CaTS wireless can be retrofitted into existing wells using wireline or coil tubing and can be externally or internally mounted on a tailpipe below a permanent packer during a DST. It also deploys as part of a lower completion assembly for sand-face monitoring. After tests in the abandoned appraisal wells of Clair Field, market demand for Expro reservoir testing has grown. Wireless is now monitoring reservoir pressure in abandoned or suspended subsea wells the arctic Barents Sea and the tropical Santos Basin of Brazil. The future for CaTS technology is being developed for monitoring and control applications in advanced completions. For Expro, at least, the ultimate goal is delivering the Wireless Reservoir.

ABB Equipment for High-tech Ocean Simulator

Photo: ABB

What is reported to be the world's first circular wave and tidal current test facility is using a package of ABB electrical and control equipment, including servo drives and low voltage variable-speed drives, to simulate energetic sea-states typically found in British, European and international waters.

Located at the University of Edinburgh's King's Buildings campus, the $15 million ocean energy research facility comprises a 25m diameter test tank. A central floor section, 15m in diameter, lifts above the water and the facility is designed for sophisticated testing of wave and tidal energy devices and projects, fixed and floating offshore wind structures, and other marine technologies by applying scaled equivalents of waves up to 28m high and currents of up to 14 knots.

It is used for testing and de-risking marine energy technologies and projects at between 1/10th and 1/40th scale. The circular shape, ringed with absorbing wave maker paddles, means waves have no reflections, allowing multi-directional wave and current generation for sophisticated model testing of renewable energy devices.

The University awarded the main technical installation contract to Edinburgh Designs Limited. The FloWave Ocean Energy Research Facility is managed by wholly-owned University subsidiary company FloWave TT Ltd.

The ABB servo drives and motors and variable-speed drives are used to generate long-crested straight waves and fast currents, and the computer control system combines thousands of these simple sine waves together to build a fully controllable 'random sea' that is 99.9% representative of real sea conditions. Down either side of the tank hall 30m of marshalling cabinets, house ABB circuit breakers, contactors, relays, switches, fuses, programmable logic controllers (PLCs), servo-drives and variable-speed drives (VSDs).

The tank is encircled by a ring of 168 wave maker paddles that create and also absorb waves. Each paddle has a robust brushless AC servomotor that drives a belt running over a curved guide on the top of the paddle. The ABB BSM brushless servo motors are used to provide the full torque from zero speed with dynamic performance, as well as avoiding the wear and subsequent replacement of brushes, thereby reducing the cost of maintenance.

The velocity, position and force feedback of each paddle is controlled by its own ABB MotiFlex e100 servo drive using Ethernet PowerLink. The controller takes the signals from force transducers on the back of the paddles that sense the wave making forces. Encoders measure the paddle position and convert the signals to an algorithm that then gives instructions to the amplifiers. Ethernet Powerlink is used to give error free, high precision, real-time control from the custom controller to the amplifiers, with protection of the latter being afforded through safe stop mechanisms.

As the paddles can both make and absorb waves, the amplifiers absorb power in the incoming wave by acting as a generator. The drive system returns the energy back into the DC bus system, rather than wasting it by dumping the energy through large resistors.

Each motion control drive is fed from a common DC bus, the DC voltage of which is generated using an ABB ACSM1

drive which is linked to the AC mains supply. Rather than use a conventional front end, the amplifier runs as a line regenerative supply, thereby driving the excess energy from the DC bus back into the mains system.

Twenty-eight submerged flow-drive units simultaneously and independently drive current across the tank in any direction, with maximum current velocities of up to 1.6 meters per second through the test volume. The current mode is ideal for testing both single devices and tidal arrays, and can even be used to operate the tank like a massively wide tow tank.

Each 1.7 m diameter impellor is directly driven by a permanent magnet synchronous motor which in turn is speed controlled by a 46 kW/60 kVA, ABB industrial drive, ACS800, controlled through CANopen communications via a third party controller. The bespoke impellors can each move more than five tons of water per second.

It was important that a drive was selected which did not need any encoder feedback, so as to reduce any additional cabling or devices underwater. ABB's direct torque control (DTC) is a sensorless motor control platform that provides the permanent magnet motors with low speed and torque accuracy, within 1% of demand; thereby recognizing the rotation without any position feedback devices. The 28 VSDs are housed in electrical cabinets situated alongside the tank. The drives are packed in close proximity within the cabinets and to help save space, a common busbar system is used to transfer the three-phase power to all of the drives. Each drive is given a different speed reference and it uses its internal logic and control systems to make the sensorless vector motors rotate at the speed needed to generate the linear profile of current in the water.

Having so many drives rated at 46 kW on a 1 MW transformer, generates multiple harmonics. Using diode bridges with a DC bus was not an effective option. For this reason, low harmonic versions of ABB industrial drives with an active front end were selected to mitigate the impact of harmonics on the mains supply.

The ABB drives are fitted with safe-torque off (STO), so if there is ever a problem within the tank, such as someone falling into the water, then the STO will cut the output to the motor.

The 15 m diameter hydraulic raiseable floor is controlled via an integrated ABB programmable logic controller (PLC), conforming to ISO 13849-1. The PLC also controls the filling of the tank and the movement of the access and instrumentation gantry using a CANbus to Ethernet link.

www.abb.com

Retrieving Valuable Cargo from the Seabed

Surveyors are usually engaged to investigate the cause, nature and extent of a claim, damage or incident. Their role in managing projects to salvage cargo is less known. Peer van Oosterhout and Ad de Klerk from BMT Surveys share their experiences in salvaging a cargo worth several million dollars from the seabed in the Mediterranean.

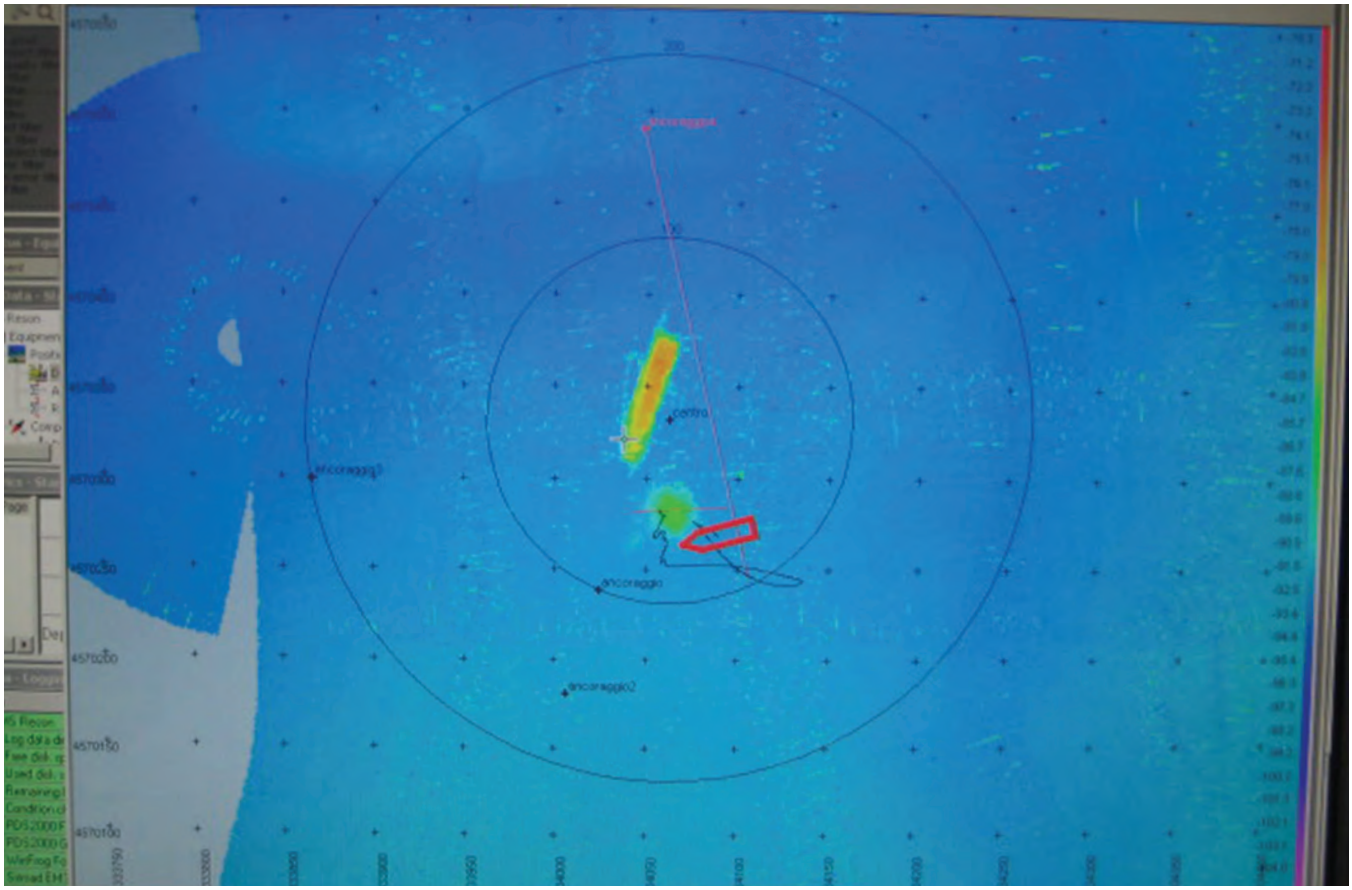
Recently, BMT Surveys in Rotterdam was approached by a major European-based underwriter, to investigate the possibility of salvaging a high value cargo from a vessel that had sunk in about 100 meters depth of water in the Mediterranean. Even though the cargo value was significant, the location and other operational considerations made the salvage venture potentially marginal if it was not carefully managed with time and costs controlled.

The initial appointment was to arrange and carry out a feasibility study to assess how much cargo could potentially be recovered and to gauge whether it was commercially and operationally viable. In coordination with the insurer, a diving survey and salvage company was appointed with an appropriate survey vessel to conduct a sonar side beam survey of the site which was 35 nautical miles from the shore. With BMT in attendance, a sonar side scan survey was carried out. This was then followed up by the use of a remotely operated vehicle (ROV) equipped with underwater video equipment.

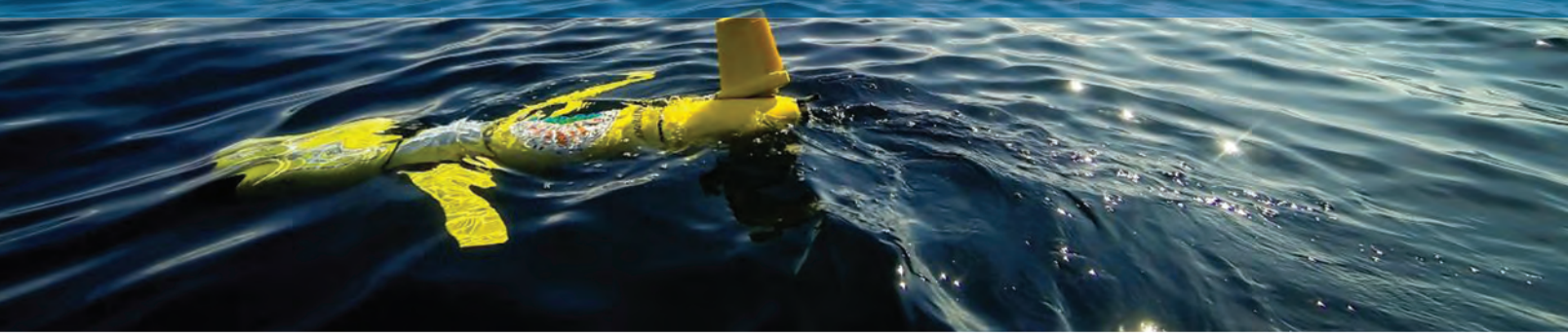
Once these operations were completed, the collected data was analyzed. The analysis confirmed that the majority of the cargo lay scattered on the sea bed close to the ship. This allowed the cargo to be accessed without having to disturb the ship, which would have resulted in a larger and more costly operation. The insurers were provided with a report, including video footage of the wreck site which supported the opinion that, with the correct equipment, about 75% of the cargo could be salvaged. Subsequently, insurers decided to salvage the cargo and BMT was appointed to assist and manage this recovery process. This included; liaison and negotiations with authorities and interested parties, finding a safe and secure port to land and store the recovered cargo and on-the-spot monitoring of the operational activity. BMT also assisted the insurers with the sale of the recovered cargo.

The operation took nearly four weeks and eventually 80% of the cargo was recovered. The proceeds of the salvage sale were significant and concluded a successful operation.

www.bmtsurveys.com



AUV Monitors Environment at Underwater Mine



Blue Ocean Monitoring (BOM) completed a contract in Indonesia working for PT Newmont Nusa Tenggara (PTNNT). BOM's task was to use its Slocum Glider to monitor PTNNT's Tailings Placement Program at its Batu Hijau copper-gold mine in Sumbawa, Indonesia. The program involved the tailings from the mine being piped (3.2 km) out to sea and deposited off the continental shelf, where the depth reaches in excess of 4,000m.

BOM's autonomous underwater vehicle (AUV) Slocum Glider was deployed to monitor that the tailings were not being disbursed into the coastal environment of Sumbawa or surface waters. The monitoring program lasted for three weeks.

"The project ran smoothly from start to finish and the data returned by the glider showed the Placement Program is proving to be a success," said Simon Illingworth, CEO of Blue Ocean Monitoring. "The Glider was able to determine quickly at the outset of the project whether Newmont's Tailings Placement Program was doing what it had been designed to achieve. This was very important given the cost, magnitude and environmental sensitive nature of the program."

BOM has a fleet of four gliders, making it the largest commercial Slocum glider operator globally, the company noted. The glider provides persistent near-real time ocean information via a secure proprietary data acquisition and visualization system.

www.blueoceanmonitoring.com

(Photo: Denny Cornelisson)

Subsea Infrastructure Growth Tempered by Oil Price Collapse

By Ben Wilby, Douglas-Westwood

Despite growth in total Capex, the outlook for subsea hardware is significantly less positive than it was previously. This is due to the major decline in oil price which has seen the price of a barrel go from a peak of $111bbl in June 2014 to below $50 in January 2015, recovering to around $60 in April 2015.

The high oil price over the last few years was driven by demand, particularly from China. In recent months, however, decline in demand from regions such as Asia, Europe and North America has led to supply overweighing demand, resulting in falling oil prices. The other major factor is the surge of U.S. shale oil production, while the decision of OPEC to defend its market share rather than oil prices by not restricting output has piled further misery on prices.

This will have a major impact, limiting the number of new projects sanctioned and reducing the expected year-on-year growth till 2018 when Capex declines. The impact of the oil price decline on projects already sanctioned will be limited, as in most cases the Capex has already been assigned and at this point operators are extremely unlikely to stop work on a development. Another reason that Capex will not decline too significantly is that some projects, such as ENI's OCTP, have been ordered despite the low oil price. It is also important to note that many project will be deferred, not cancelled, and

longer term growth is expected in the subsea market.

Other issues such as the Petrobras scandal and political issues in a number of key regions also add uncertainty to the final years of the forecast.

Drivers of Subsea Hardware Installation Activity

Despite the collapse in oil price there will be a number of other supply and demand side drivers that impact on subsea hardware installation activity:

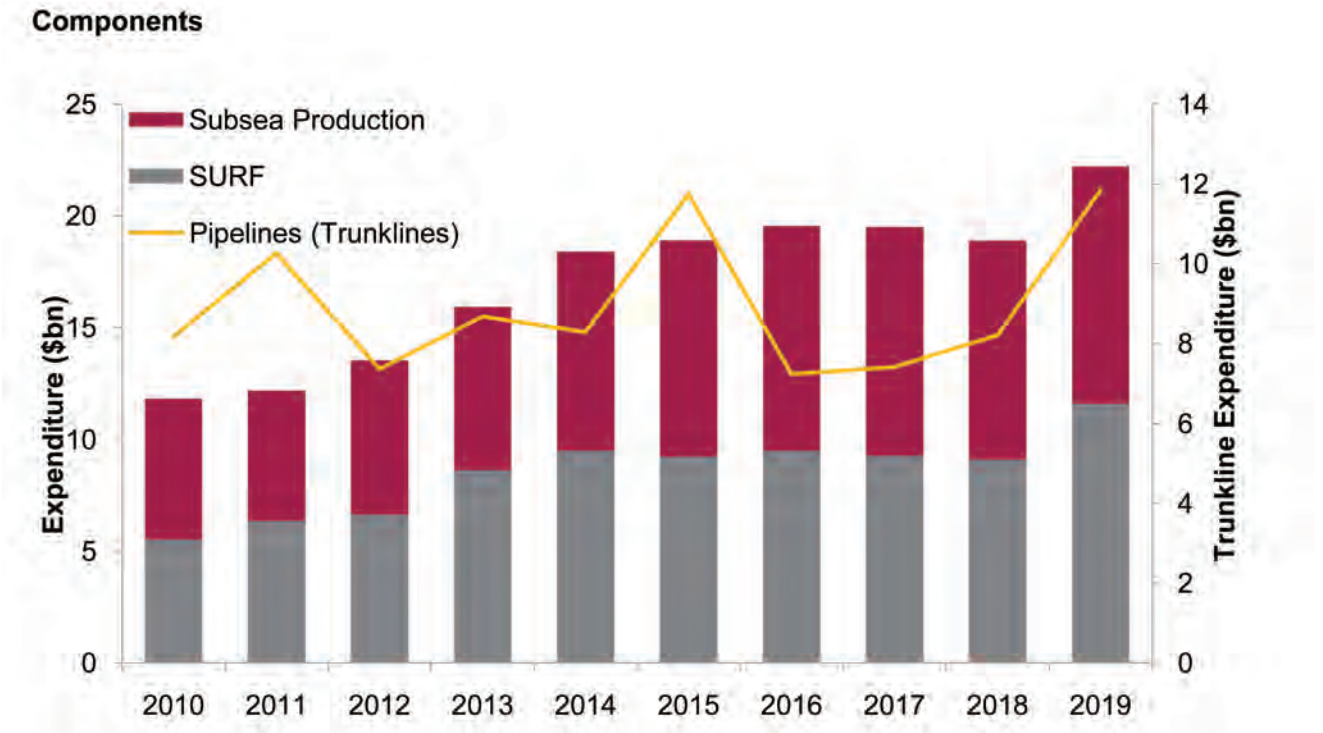
- ***The move to deepwater;***
- ***Development of complimentary production technologies;***
- ***Marginal and remote field development;***
- ***Fields in harsh environments.***

It is vital that declining production from maturing basins is replaced. Long term demand for oil and gas is increasing in developing regions and there is added pressure to explore and produce in deeper waters as a result. High oil prices have enabled investment in deepwater developments and technology, with previously unviable or marginal projects able to be developed in these Capex-intensive situations. The period of high oil prices has also led to exploration of ultra-deep basins and the Stones FPSO will be the deepest FPSO ever installed when it begins production later this year. Both exploration and development will now suffer due to the collapse in oil price as operators aim to ensure low costs and high margins are established in projects before approving them. Despite this, most oil companies take a long-term view of the market and will only defer, not cancel, these high Capex projects.

Marginal fields remain a key driver but the impact of these fields will be lessened by oil price uncertainty. Sanctioned marginal projects such as **Kraken** will continue as planned but new projects face a high risk of development plan delays at this time. Similarly to deepwater projects, marginal field production will be crucial for meeting the world's energy needs as well as ensuring the continued development of mature basins such as the North Sea. The recent U.K. tax incentives are an example of how these marginal fields can be made economic and attractive to operators.

The subsea sector has seen rapid technological progress in recent years to ensure that hardware can withstand higher pressures and more expansive subsea developments. This has enabled cost-effective production to develop – tying in additional wells to a single manifold, for example. These small tie-ins can be uneconomic with a low oil price and due to the speed with which they can be installed once sanctioned, a number of them are likely to be delayed until an oil price rise is seen. In addition, subsea processing technology is slowly maturing, enabling production from challenging reservoirs including heavy oil. This is still relatively early in development however and use of the technology will be impacted by the lower oil price. A lot will depend on how successful the large, high Capex Åsgard B compression unit is. If this proves to be a worthwhile addition to the field and operates without issues it will be a lot easier for other companies to sanction them for fields they believe require subsea processing.

Operators are becoming increasingly interested in the development of 20,000 psi hardware as fields with higher pressures and temperatures are developed. Trees rated at 20k psi are still some way from being ready for use with the first likely to be on the **Kaskida–Tiber** development in the Gulf of Mexico in



the early 2020s. FMC is still expected to continue development of this technology but the uptake from operators will be constrained until a high sustained high oil price convinces them that 20,000 psi projects are worth the high capital costs.

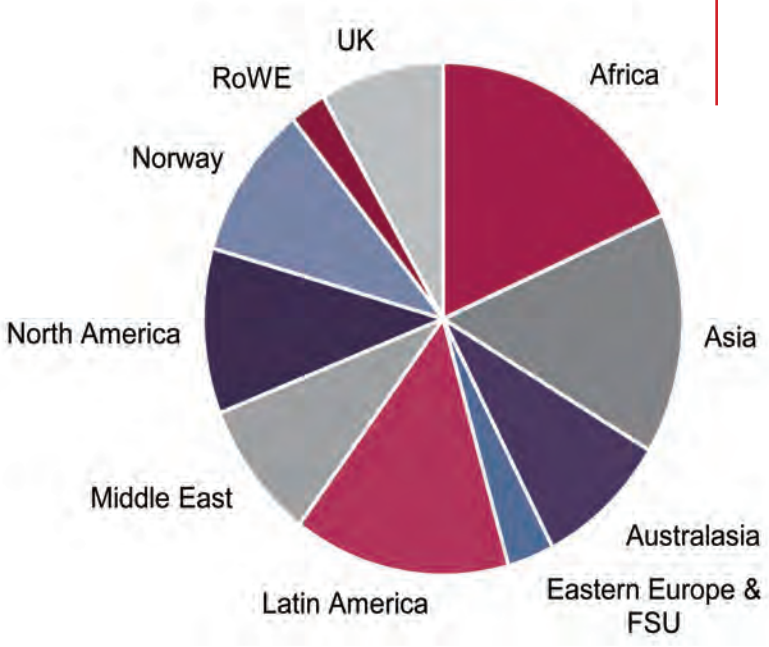
Components

Subsea production hardware will attract $50bn of expenditure 2015-2019, driven by a number of large projects in deepwater such as the 65 tree **Kaombo** project that was sanctioned early last year. Projects like this will still go ahead, having already been commissioned and demonstrate why the market will remain steady in 2016-2017 despite the low oil price.

The SURF market will approach $48bn Capex and this is boosted by a revision of development plans that mean that projects are developed as tiebacks rather than with their own fixed or floating platform, increasing the length of required SURF units. This is often a cheaper solution and in a time when companies are under pressure to cut costs, will be an attractive option. As well as this the development of remote fields and the addition of new project phases will drive expenditure in this category.

Other factors such as the use of certain production facility designs drive higher installation Capex of particular pieces of hardware. For example subsea completion of wells with a floating production unit, which is seen to be more common in regions such as African and Latin American deepwater developments, directly drive more installations of larger riser bundles increasing DW's view of forecast spend for SURF units.

Trunkline spend is forecast at $46bn and is driven by a number of large projects. The market for trunklines will remain relatively consistent 2016-2018 but this will represent a decline from a high of 2015. This high is a result of lines such as the deepwater 718km **Ichthys** pipeline that is due to be installed by Saipem this year.



Analysis of the top five subsea equipment vendors indicates that backlogs are at near record levels of over $17bn. However, the industry-wide backlog was 6% lower than in Q2 2014, but 1% higher than a year ago.

The high level of backlogs will ensure that the next few years will feel busy for industry players, as they work through their current order books and this is reflected in their share prices. Since the oil price collapse subsea hardware manufacturers indexed share price has declined 34%, significantly less than others such as drilling companies.

Over the next two years a decline in backlogs is expected, as new orders for equipment dry up in the low oil price environment. Major subsea players such as FMC and Aker are likely to be affected by this and as the number of orders shrinks they will likely have to lower prices to ensure they win orders. It is not a simple issue though and lower costs will have to be balanced with maintaining high safety standards. This expected increase in price competition is going to be important in an area where equipment costs continued to grow even as the oil price peaked.

It is important to highlight however that this is only expected to be short term and the growth in Capex spend after 2018 demonstrates that orders will grow again after a few lean years.

Africa to be Highest Spending Region

Africa will have the highest installation Capex over the forecast period and account for 18% of the total, mainly due to a number of large subsea developments including **Kaombo** and **Egina**. Despite this the large number of deepwater projects, high local content requirements and political instability, mean Africa will be heavily impacted by the oil price collapse. A number of projects that were due to be sanctioned in 2015 are likely to be deferred until they make sense economically and the Nigerian **Bonga South West-Aparo** project is an example of this, with operator Shell deferring the project as a way of cutting costs. As a result Capex in the region will decline significantly 2017-2018. A number of projects will still be sanctioned with ENI recently ordering for its **Offshore Cape Three Points** development in Ghana.

Latin America accounts for more than 15% of our forecast subsea Capex and most of this is from Brazil. Project execution is a major issue for Petrobras with a 70% local content requirement and engineer shortages placing pressure on the supply chain, inflating costs (up to 50% has been reported) and delaying delivery of production systems (predominantly FPSOs). Continued challenges at major Brazilian yards have led to work being farmed outside of the country. The major

issue for Brazil however is the scandal that has embroiled NOC Petrobras. This has led to the departure of most of the senior management team and the banning of many companies from bidding on projects, which will likely see costs squeezed, higher levels of scrutiny and project deferrals as a result. However, due to the long lead times for much of the hardware in Brazil the major impact of the scandal isn't expected to be seen on installation Capex until after the forecast period.

Asia will also see high levels of hardware spend, accounting for almost the same amount as Latin America. Much of this expenditure will be for trunklines and export lines as opposed to subsea production as fixed platform developments remain a more popular option for fields in the region.

Elsewhere subsea hardware spend is split over the globe and every region will see some expenditure. In certain regions (such as the Middle East) this will be mainly for trunklines while others will see spend mostly on subsea production equipment.

Conclusions

Overall the market for subsea hardware will be constricted as the effect of the low oil price hits numerous projects on a global basis. While this will be negative for both operators and subsea manufacturers over the next few years, it is unlikely to be a lasting trend. Oil companies tend to take a long term view of the market and while there will be delays most projects will still be sanctioned once the oil price stabilises and equipment costs lessen.

One of the sectors most affected will be the hardware manufacturers who will have to lower prices and become competitive to win the smaller number of orders available. Due to the operator focus on cutting Capex this was inevitable but it will be made worse by the significantly reduced oil price. Regionally Africa will see the most subsea Capex over the forecast period. This will however be highly affected by the collapse in oil price. Deep water developments are common and complex local content issues prevalent in many African countries leading to high development costs. Following Africa is Asia and Latin America which each have a 15% share of Capex. It is not just these regions however and spend will be spread globally – demonstrating the growing requirement for subsea hardware worldwide.

The Report

The 5th edition of DW's World Subsea Hardware Market Forecast 2015-2019 details specific subsea hardware trends by region and component, supported by analysis, insight and industry consultation. http://marketreports.douglas-westwood.com/report/oil-and-gas/world-subsea-hardware-market-forecast-2015-2019

Offshore Renewables

Wind, Wave & Tide The Future is Now

By Josh Keefe

Credit: London Array Limited

While the recent swoon in world oil and gas prices has predictably cooled a number of offshore renewable projects, there is a palpable change regarding the way in which the world views renewable energy. Renewable energy projects, at one time merely serving as window dressing, are slowly weaving their way into the mainstream energy mix, with European countries, namely the U.K., leading the way.

In November world leaders will arrive in Paris to negotiate a new global agreement on climate change, one that is scheduled to go into effect in 2020, a measured designed to prevent the world's temperature from rising. The U.S. has already submitted its Intended National Determined Contribution to the UN Framework Convention on Climate Change in advance of the meetings in Paris, and in that document the Obama administration has set a formal goal of reducing emissions by 26% to 28% below 2005 levels by the year 2025.

While government targets for carbon emission reductions are a useful framework, the grunt work comes down to the researchers and engineers that are working tirelessly to tap this abundance of natural energy and deliver it efficiently and cost effectively to market.

Land based solar and wind technology have made huge gains in recent years, especially in Europe, but the ocean remains, for the most part, a vast untapped resource. This is, starting to change as offshore wind, tidal and wave technologies are in various stages of development and poised to soon become factors in the effort to reduce carbon emissions. But offshore energy also provides a host of challenges, including harsh conditions for installation and maintenance. Below we look at the three main offshore renewable energy options and examine their past, present and future.

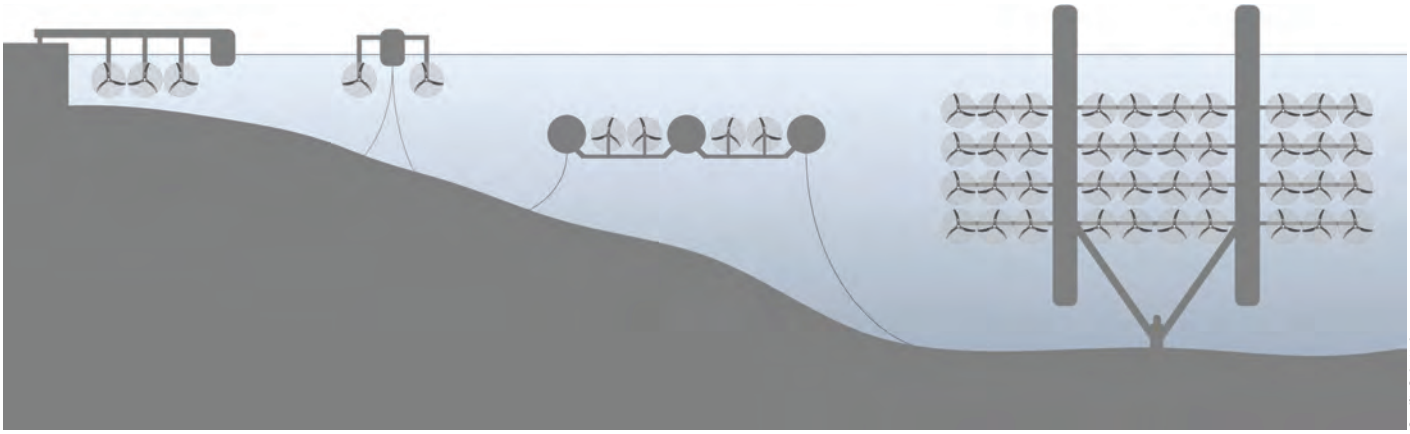
Offshore Wind

Offshore wind energy is by far the most developed offshore renewable energy resource. According to the Global Wind Energy Council's (GWEC) annual report, 8,771 megawatts (MW) of electricity was generated by global offshore wind resources in 2014, which is enough to power between 2 and 2.6 million U.S. homes.

The first offshore wind farm was installed off the coast of Denmark in 1991. Since then, the growth of offshore wind has been almost exclusively in Europe. Of the 8,771 MW of energy capacity from global offshore wind in 2014, 8,045 MW of it was generated in Europe, mostly in the North Sea. And within Europe, the U.K. dominates, accounting for 55.9% of all installations. That includes the London Array, currently the largest offshore wind farm in the world, which is comprised of 175 turbines covering an area of 100 sq. km with a capacity of 630 MW, or enough to power 500,000 U.K. homes a year. In February, the Dogger Bank Creyke Beck project was approved by the U.K.'s energy secretary. The project will feature an array of up to 400 turbines and could fulfill 2.5% of the U.K.'s electricity needs (while costing £6bn to £8bn).

Denmark is the next largest producer of offshore wind energy, followed by Germany (Denmark, the U.K., and Germany comprise 84.7% of all European offshore wind capacity). Outside of Europe, the remaining capacity exists in Southeast Asia, with China (669.9 MW) leading the way. China has made a huge commitment to offshore wind in the past year, adding 61 offshore wind units with a total capacity of 229.3 MW in 2014, compared to 39 MW added in 2013 (that's a 487.9% increase). Japan (49.7 MW) and Korea (5 MW) also

SIT turbines can be combined with practically any kind of support structure: fixed land-based, floating, semi-submerged or fully submerged platforms can be used. Even sluice gate type installations are possible.



Credit: Schottel

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

Schottel Steps Up

Niels A. Lange,
Managing Director
SCHOTTEL HYDRO

Last year, German propulsion company Schottel spun off its hydrokinetic energy offerings into a new subsidiary, Schottel Hydro. The company is already making an impact in the field of tidal energy with its Schottel Instream Turbines (SIT), which are adaptable for three different flow speed classes and can be combined with floating, submerged or semi-submerged platforms to create an easily installed and maintained tidal power solution. Schottel Hydro's Managing Director, Niels Lange, believes open instream turbine technology combined with platforms is the future of tidal energy, and that that future is nearly upon us.

"In comparison to tidal barrage or lagoon plant, we see significantly lower investment costs for open instream turbines and presumably also less impact on the environment," Lange said. "Commercial devices and even small tidal arrays are now being financed and will be commissioned within the next two years."

The SITs were designed for cost effectiveness, Lange explained. They are small and simple, with each turbine weighing about one ton, and they are easily installed when combined with a floating or semi-submerged platform, like SCHOTTEL Hydro's Triton or SME's Plat-O platforms.

Schottel Hydro's technology is being used in several upcoming tidal projects. SIT turbines, already under testing, will be grid-connected via Plat-O platforms at the European Marine Energy Commission's (EMEC) Fall of Warness tidal test site in Scotland this August, which will eventually deliver a 1MW capacity. Another SIT will be deployed at the Bluewater Consortium's Texel project in the Netherlands. Schottel Hydro will also partner with its Halifax subsidiary Rock Tidal Power to provide its TRITON platform technology to the Fundy Ocean Research Center for Energy (FORCE). And finally, the company will be supplying the hub and pitch mechanism for the Meygen project early next year.

have offshore wind capacity.

The U.S. does not currently have a commercial offshore wind farm, although the U.S. Department of Energy's recent Wind Vision Report say that the U.S. has 4,200 GW of offshore wind technical resource potential. Developing just a quarter of that capacity would be enough to power the entire U.S. That development is in its infancy, but it has started: in April construction began on the Block Island project 18 miles off the coast of Rhode Island, which is scheduled to start supplying power by the end of 2016.

"What we really need to see is project number one," said John Rogers, Senior Energy Analyst at the Union of Concerned Scientists. "That's what I'm most excited about, whatever project is the first to get steel in the water and get electrons into the wires. It is really important for people in the U.S. to see one of these projects, to be able to kick the tires on it and appreciate offshore wind's value."

Tidal

While the technology used to capture energy from offshore wind has more or less been established, capturing the power of the tides is a bit trickier. In total, the world has about 500 MW of power generating capacity and that could rise to 800 MW by 2020. But tidal energy's worldwide capacity has been estimated to be 80 GW. Several different methods have been used to capture the power of the tides, which has the advantage of being consistent and predictable compared to other renewable energy sources, but none has become the clear standard, in spite of the fact that the first large-scale tidal power station, the Rance Tidal Power Station in Brittany, France, will be 50 years old next year.

Rance uses a form of technology called a tidal barrage, which

is a structure placed across a river or bay that captures the energy from the flow of the tides. Sihwa Lake Tidal Power Station in South Korea, which opened in 2011 and is the world's largest tidal power station, also uses tidal barrage technology to create a 254 MW capacity (Rance's capacity is 240, which, combined with Sihwa, accounts for just about all of the world's capacity).

The future tidal lagoon generation, a new form of harnessing the power of tides, may be largely dependent on one project, the Swansea Bay tidal project on the coast of Wales. Swansea is likely to cost $1.6 billion, and is entering the final stages of government approval. The project will be a 4.4 square mile lagoon. When the tide rises, the lagoon will fill, turning turbines, and when the tide lowers, the water would stay in the lagoon, before eventually being released, again turning the turbines.

Besides tidal barrages and lagoons, there are a great deal of tidal stream generator designs that are both currently in the field and under development. Many of these devices are different configurations of turbines that operate according to the same principles as wind turbines and are either anchored to the ocean floor or to a floating platform. Construction has just recently started on what is being called the largest tidal energy project in the world, the MeyGen project off the northeast coast of Scotland. The project will use seabed-anchored turbines to generate a nearly 400MW capacity by the early 2020s.

Wave Energy

Wave energy is created by harnessing the up and down, rollicking energy of the waves, and is more challenging to capture than tidal energy. The potential, however, is enormous: the Electric Power Research Institute (EPRI) published a study in 2011 that estimated that the recoverable wave energy potential along the U.S. shelf is one third of the entire U.S. electricity usage.

There was a small installation of wave energy converters launched off the coast of Portugal in 2008, but that was shut down due to financial difficulties, and the company that was developing the technology, Pelamis Wave Power, went under last year. Even heavy hitters like Lockheed Martin have failed to produce wave energy solutions: the company's partnership with Victoria Wave Partners to build what was called the world's largest wave energy project off the coast of Victoria, Australia appears to be dead. And in December of last year, the U.K.'s Offshore Renewable Energy Catapult (ORE) warned in a report that the wave energy market "is strategically important to the U.K. but is on the brink of foundering."

Current wave energy designs include oscillating water columns, (a device that uses waves to push air upward through a turbine), attenuators (think of a long snake that slithers on top of the waves), overtopping devices (which create reservoirs that are filled with waves), and point absorbers, which are floating buoys that have internal parts that move up and down independently from one another to create energy.

In spite of all of this uncertainty around design, Australia switched on its Carnegie Perth Wave Energy Project in February, which is now feeding energy into HMAS Stirling, the largest naval base in Australia. The project deploys Carnegie Wave Energy Limited's CETO technology, which uses the motion of fully submerged buoys to drive seabed pump units.

While offshore wind, tidal and wave energy all have enormous potential, it may be that the future of offshore renewables rests in the consolidation of these technologies to streamline maintenance and transmission costs.

"The best potential eventually might be a combination grouping different technologies," Rogers said. "You could imagine an offshore wind farm that also has wave generators stationed around it."

A New Age for Underwater Autonomy

By Kira Coley

It is an exciting era for ocean exploration in a time when several scientific fields are beginning a new phase of discovery through advancements in underwater technology. While the use of autonomous underwater vehicles (AUVs) have been key to propelling scientific investigation forward, the complexity, time and resources needed to plan these missions have begun the quest of 'true autonomy' by engineers in the ocean communities. Now a new programming approach developed by engineers at MIT offers AUVs more "cognitive" capabilities, enabling these systems to form their own mission plan with minimal input from their human counterparts.

The Role of Engineers in AUV Missions

Since the 1960s, AUVs have been invaluable in scientific investigation and discovery, giving researchers access to some of the world's most remote, and often dangerous, underwater locations. While a proven tool in oceanic research, AUV missions are complex, costly and time-consuming, requiring an expert team of scientists and engineers to safely guide the AUV while capturing the all-important scientific data.

Although the mission objectives are defined by the scientist, it is the engineer who communicates to the AUV what order each site should be visited, how each location is surveyed and which route is safe for the vehicle. This mission schedule can be affected by a number of environmental conditions, such as the effect of tide on currents, and environmental features such as reefs, mounts and other vehicles which increase the risk of collision.

Being central to the missions' success, engineers must consider trades between the growing uncertainty when navigating under the ocean's surface, against the cost and benefit of surfacing to communicate with satellites - an often costly process using both valuable time and energy resources. Occasionally scientific objectives may need to be sacrificed so the mission can be completed within the given timeframe and energy margins.

** All images courtesy of the researchers*

Researchers watch underwater footage taken by various AUVs exploring Australia's Scott Reef.

"Currently, the scientists will tell an engineer their science goals, priorities and additional constraints, such as when to examine different science areas, and what to avoid. The engineer uses his or her knowledge of the vehicle, plus a map of the area to come up with a sequence of low-level commands (called a script) to tell the vehicle where to go, and what to do. Commands include 'follow a straight line to a way point,' 'surface,' and 'establish a satellite link.' For the new generation of small vehicles, like the Slocum glider, the same person might be playing both the role of scientist and engineer," says Brian Williams, a professor of aeronautics and astronautics at MIT.

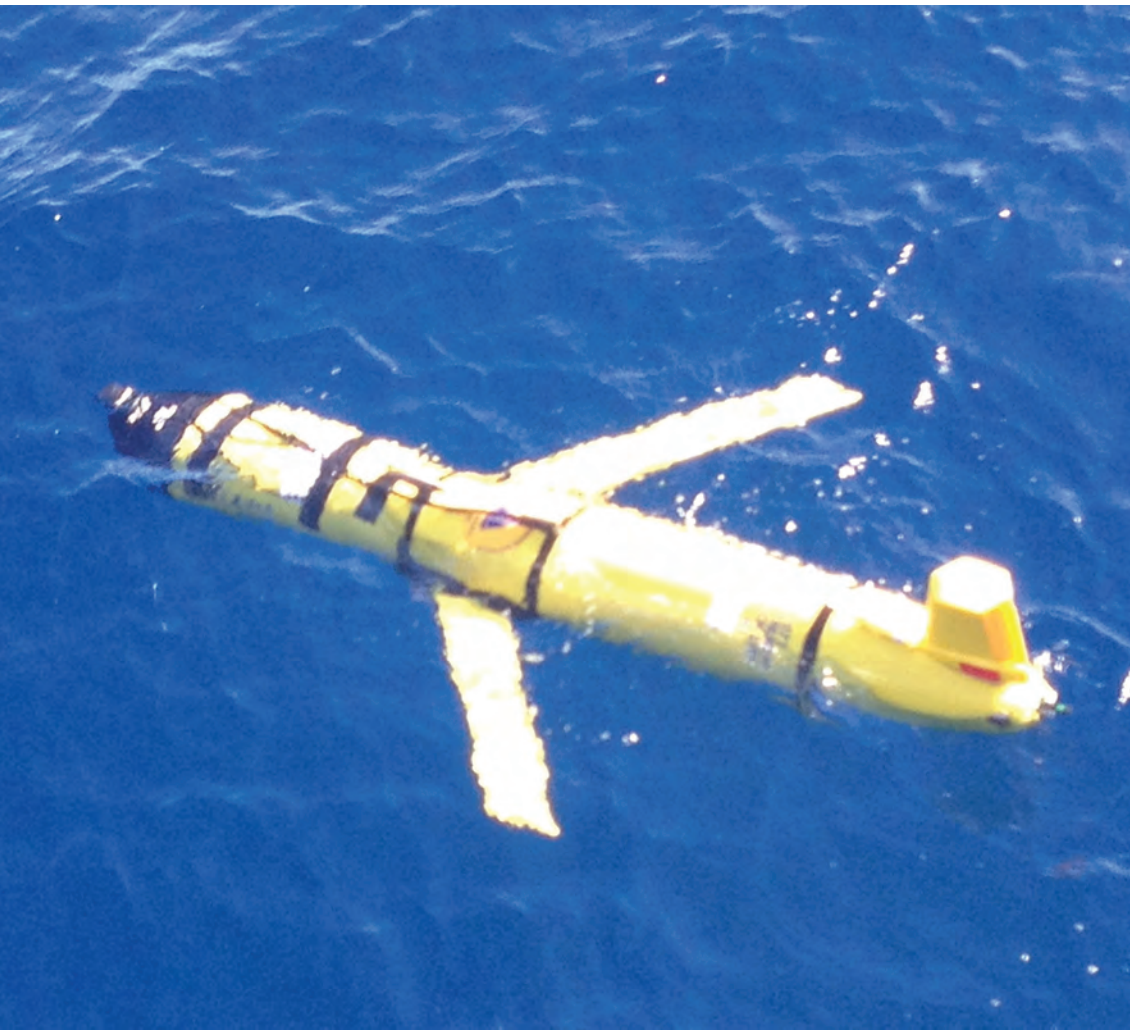
While these robots are effective at carrying out low-level tasks specifically assigned to them by human engineers, it is a tedious and time-consuming process. For years engineers have been working on improving the autonomy of these underwater vehicles in an effort to reduce the level of human control and provide AUVs with robust decision-making capabilities.

A New System for Underwater Automation

Professor Brian Williams is the principal developer of a new mission-planning system for AUVs, developed by MIT engineers in collaboration with Dr. Richard Camilli's team at the Deep Submergence Lab at the Woods Hole Oceanographic Institute (WHOI). The new programming approach gives robots more "cognitive" capabilities, enabling humans to specify high-level goals, while a robot performs high-level decision-making to figure out how to achieve these goals.

Williams explains, "We have developed a system in which the AUV is given the scientist's goals directly. The vehicle then automatically generates the script of commands that the engineer would normally construct by hand. This requires the AUV to search through a large space of possible scripts for the one that it determines is best."

Mission planning and navigation are repeatedly performed as coordinated tasks online to form a mission plan based on



A Slocum glider, used by the MIT team, navigates underwater.

updated information on the vehicle status, environmental conditions and mission progress. Each time the AUV communicates an update by satellite it revises its plan based on the new information, and begins executing a new script. This allows the vehicle to adapt to potential dangers and exploit potential opportunities that occur along the way.

Over the last decade, one of the key challenges for AUV engineers has been creating a system that can automatically search through a large set of plans for one that is appropriate for its mission objectives. Traditionally, autonomous systems either avoid the ability to search through options, are constrained to explore a small set of options, or take hours to form a suitable plan. Modern planners can now search through a very large set of options in seconds. Another challenge is safely navigating areas of scientific interest which are also dangerous to the vehicle, such as reefs. This requires planners that can reason about uncertainty and risks to ensure that they leave an appropriate safety margin, and planners that replan continuously.

This new system allows the robot to plan out a mission, choosing which locations to explore, in what order, within a given timeframe - a process usually determined by the engineers. The system also plans how to safely and efficiently navigate the vehicle between and within the science areas. This includes deciding how close to get to parts of the reef, given the uncertainty of currents, and when to surface, in order to gain a better position estimate. If an unforeseen event prevents the robot from completing a task, it can choose to drop that task, or reconfigure the hardware to recover from a failure.

In March this year, the MIT engineers, along with groups from WHOI, the Australian Center for Field Robotics and the University of Rhode Island, tested the new mission-planning system on an autonomous underwater glider during a research

Several classes of autonomous underwater vehicles await deployment on the deck of the Falkor, off the coast of western Australia.

cruise off the western coast of Australia.

"The trials went even better than expected. We started developing the capability in layers and adapted them each day based on our experiences," recalls Williams. "First, Rich Camilli's team worked to ensure that the Slocum glider was functioning properly, was well calibrated and reliable. We then added reasoning capabilities in layers. Several different approaches to navigation was tested, until we found one that managed risk and energy effectively. We then incorporated the ability to monitor the environment, and to replan the vehicle routes as information was updated. This process was repeated for the mission planner. Finally, we introduced more complex science goals, where the vehicle was asked to explore areas that were normally considered too dangerous for gliders operated using traditional methods."

The Slocum glider, using this system, was able to adapt its mission plan to avoid getting in the way of other vehicles, while still achieving its most important scientific objectives. If another vehicle was taking longer than expected to explore a particular area, the glider would reshuffle its priorities, and choose to stay in its current loca-

"The new programming approach gives robots more "cognitive" capabilities, enabling humans to specify high-level goals, while a robot performs high-level decision-making to figure out how to achieve these goals."

tion longer in order to avoid potential collisions. After a week of autonomously operating the glider, the team found that the new approach successfully enabled the vehicle to perform science in areas that were previously only possible using more costly, traditional AUVs.

"I don't think in terms of 'true autonomy'. I view the future as a partnership between human scientists and autonomous vehicles."

"Over time these vehicles will become increasingly able to evaluate a progressively large set of options, given what they have been told. In this way they are like a new form of calculator. But the vehicle plans are only as good as the model that the scientists and engineers give them," says Williams. "Humans will guide the vehicles in the form of goals, priorities and safety constraints. They will need to tell the vehicles what is important, what risks are acceptable, and what uncertainties to model."

Autonomy in Sea and Space

The autonomous mission-planning system, named Enterprise after the fictional starship in the "Star Trek" franchise, is similar to one that Williams developed for NASA following the loss of the Mars Observer, a spacecraft that, days before its scheduled insertion into Mars' orbit in 1993, lost contact with NASA. Based at NASA's Ames Research Center, Williams at the time, was tasked with developing an autonomous system that would enable spacecraft to diagnose and repair problems without human assistance. The system was successfully tested on NASA's Deep Space 1 probe, which performed an asteroid flyby in 1999.

"An autonomous underwater vehicle can be thought of as a cross between a rover or deep space probe, and an autonomous air vehicle."

"Like space exploration, the underwater vehicles are performing science in an unreachable area, and with limited communication. We talk to a Mars Rover once a day and we talk to the autonomous underwater vehicle only when it goes to the surface. Like an air vehicle, the underwater vehicle flies through the ocean, while being buffeted by currents. The uncertainty that results from this dynamic environment is a very significant issue," explains Williams.

"A key difference between ocean and space, is that the most complex space missions, like Cassini and Curiosity, have an enormous amount of redundancy, and a large number of science instruments. Cassini and Curiosity both cost in excess of a billion dollars, so it's hard to take risks with these vehicles, hence Mars rovers today use very limited autonomy. Our work at NASA focussed on systems that could diagnose and repair these space systems automatically. The underwater vehicles are much simpler internally, so our focus is less on diagnosing and repairing internal hardware, and more on navigating the ocean safely."

Future of Underwater Autonomy

Autonomous vehicles are already being used in support of a very broad range of missions including monitoring reefs and fisheries, deep sea exploration, archaeology, oil exploration, disaster response and security. By giving robots control of higher-level decision-making, engineers are free to think about overall strategy, while AUVs determine for themselves a specific mission plan. This new ability could also reduce the size of the operational team needed on research cruises and enable robots to explore places that otherwise would not be traversable.

As we enter this new age of underwater autonomy, AUVs will provide ways to persistently monitor large areas in a much more cost effective manner. Today, a cruise typically operates a single autonomous vehicle, with costs in excess of a million dollars, performing limited duration missions. In contrast, vehicles within the realm of $100K can be deployed by two people by hand, operate for weeks at a time, and require less time and expertise to command. With this relatively low cost, a future in which many vehicles are performing science exploration cooperatively can be anticipated.

"Our friends who are AUV operators and Mars rover drivers both complain that they spend too much time generating low-level command sequences, and do not have enough time to think strategically, either in terms of the science or engineering contingencies. We hope that our tools offer them more time to spend focussed on what they want to do, and are uniquely qualified to perform. Therefore this system could shape a new role for engineers so that they are able to think strategically, while the vehicles do the boring tasks of working through the detailed plans and scripts," says Williams.

"Rich [Camilli, WHOI] and I are excited that we have made significant progress towards controlling a single autonomous vehicle robustly. This enables us to turn our focus to the vision that many have had, of allowing scientists to control larger networks of autonomous vehicles of many different types. In the future we would like to operate these networks persistently, without the current reliance on expensive ships and similar infrastructure."

Sailbuoy

Ocean Business in Southampton again proved to be a launching pad for technologies large and small. MTR caught up with David Peddie, Manager of Offshore Sensing AS, to discuss his company's unique Sailbuoy product.

By Greg Trauthwein, Editor

For MTR readers not familiar, can you provide a brief background on your company?

Offshore Sensing was established in 2014 as a spinoff from Christian Michelsen Research Institute (CMR). CMR has a long history in producing both anchored and drifting buoys for the open-ocean and ice-infested waters. The Sailbuoy technology development started at CMR in 2005 based on the experience of CMR buoy production and development. After many years of development and testing the Sailbuoy product is commercially available though the company Offshore Sensing who is dedicated to the development, production and sales.

So, can you tell us a bit about the Sailbuoy?

The Sailbuoy is the world's first long endurance autonomous sailing vessel. It navigates autonomously and uses wind power for propulsion. Data communication and navigational control is in real-time using the Iridium satellite system through a user-friendly system that requires limited user input. The vessel is designed for relatively long term missions (several months to a year), robustness and cost-efficiency. The standard Sailbuoy has a length of 2 m, a displacement of 60 kg, a payload of 15 kg and 30W solar panels. The Sailbuoy can be fitted with various sensors and instruments to be used

for a wide variety of ocean applications including near-surface temperature, salinity and oxygen concentration monitoring, wave measurements and acoustic communication. The Sailbuoy is designed to be easily deployed and retrieved by untrained personnel from small to large vessels.

In brief, walk us through the rationale to design this vessel ... what problem was it developed to solve?

CMR has a long history in producing drifting buoys. The advantage of drifting surface buoys is that they are relatively cheap, easy to deploy and allow for satellite communication. The rationale for the Sailbuoy came from designing a drifting surface buoy that does not drift out of the area of interest but is able to keep station without a mooring. It was initially designed to fulfil the objective of moored buoys while keeping the simplicity and low deployment costs of drifting buoys. However, we quickly found that, in addition to keeping station, it could travel efficiently along transects.

Specifically, how is the Sailbuoy designed to work?

The Sailbuoy is designed to harvest the wind power to sail, and to collect data from sensors while following a track or while station keeping in the open ocean. Inherent to the design is the high degree of autonomy. It requires little input from the user and is designed to solve most issues automatically. In effect this means that the user input is reduced to just giving it a track to follow. Data is then displayed in real-time through the user interface. Deployment and retrieval is also designed to be straightforward without the need for a crane or a large vessel.

An important aspect is that the Sailbouy was designed in Bergen, Norway for North sea and Norwegian sea conditions. These areas have often severe wind and waves in addition to limited solar power during winter. An autonomous vessel designed for these conditions has to sail well in light to severe conditions, and hardly use any energy doing it. This is the design background for the vehicle. Designing a vessel for light conditions and sunny weather would not be adequate for Norwegian waters. Using this as the backdrop, the Sailbuoy is designed to handle all North Sea conditions for months on end and to sail well in most of them. As for the limited sun energy during the winter, the power consumption of the Sailbuoy is so small that it can navigate without sun energy for months.

"...It is designed and proven for robustness with the ability to survive and operate in very rough environmental conditions and can navigate for months with little or no solar power, which is a great advantage for use in high latitudes."

What differentiates Sailbuoy from others in the market?

Sailbuoy is a long endurance wind driven vessel, low-cost, user friendly, and modular. It is designed and proven for robustness with the ability to survive and operate in very rough environmental conditions and can navigate for months with little or no solar power, which is a great advantage for use in high latitudes. In reality this means that there is no risk of losing navigational capabilities or communication due to flat batteries. It will always be online and active regardless of energy harvesting. Due to its small draft it is suitable for shallow waters to 1m depth and it can withstand collisions with ice or floating debris without breaking up, getting entangled or pulled under.

Are there any new or innovative use technologies on your vessel that we won't see on others? Please be specific.

From my background as an electronic/software engineer the Sailbuoy contains state-of-the-art low power electronics. In fact the electronics is not based on standard off the shelf boards but designed from the ground up specifically for use in the Sailbuoy. Every electronic component is chosen specifically for this purpose and all the software code is written to be as efficient and reliable as possible. Power consumption and reliability has been guiding the Sailbuoys design from the beginning.

In looking at your vessel and its capabilities, rank the top markets and/or niches you see it serving best, with short descriptions explaining why.

• ***Acoustic data retrieval from subsea instruments in real time:*** Acoustic communications enable continuous data collection with a huge potential impact on research (data recovery from conventional moorings) and oil-gas industry (monitoring of leakage, corrosion and pig - logging). Data retrieval provides operators and scientists with valuable and timely information, and further increases security and reduces risk of pollution, emissions and economic loss.

• ***Wave measurements:*** Wave measurements with spatial and temporal flexibility is a huge advantage for offshore oil and gas operations. From the science perspective measurements are scarce, and near shore regions are particularly important and undersampled.

• ***Oil spill monitoring and detection:*** In situ mapping and tracking of oil concentration in low visibility and poor weather conditions is a significant asset because present remote sensing operations for monitoring of oil slicks are hindered by poor visibility, high sea state and wind conditions

• ***Environmental monitoring and water quality:*** Sailbuoy can be fitted with sensors for water quality measurements, including conductivity, temperature sensor, oxygen optode and a fluorometer. Applications include detection of hydrocarbons, algae or chlorophyll-a activity, water turbidity, dissolved organic matter or chemical dyes. High-quality measurements of sea surface temperature and salinity over vast regions can be used to verify satellite remote sensing measurements, and to constrain numerical models.

What did you see in the world ... in the autonomous vessel world ... that told you that this was a good time to invest in a new system.

The investment of the system has been going on for 10 years, however we now see that AUVs, UAVs and Gilders are becoming widely used and the market now realises that autonomous vehicles can provide cost effective and risk reducing solutions.

When you look at the world – by region or market niche – where do you see opportunity and why?

Basically the Sailbuoy is well adapted for all open ocean areas, including large inland lakes.

However the Sailbuoy is best used in areas with low shipping density, to avoid the risk of collision and theft. It is also well suited for the high latitudes due to its unique features of power consumption and robustness.

What was the greatest challenge in bringing this vehicle from a concept to reality?

The greatest technical challenge was to enable it to navigate in storm and hurricane conditions and to withstand the severe weather in the north sea for months on end. Since the Sailbuoy is a new design for a new market it was a great challenge to get funding for further development. It was difficult to convince people that autonomous vessels is the way of the future. We received great help from The Norwegian Research council and internal funding at CMR to bring this vehicle to market.

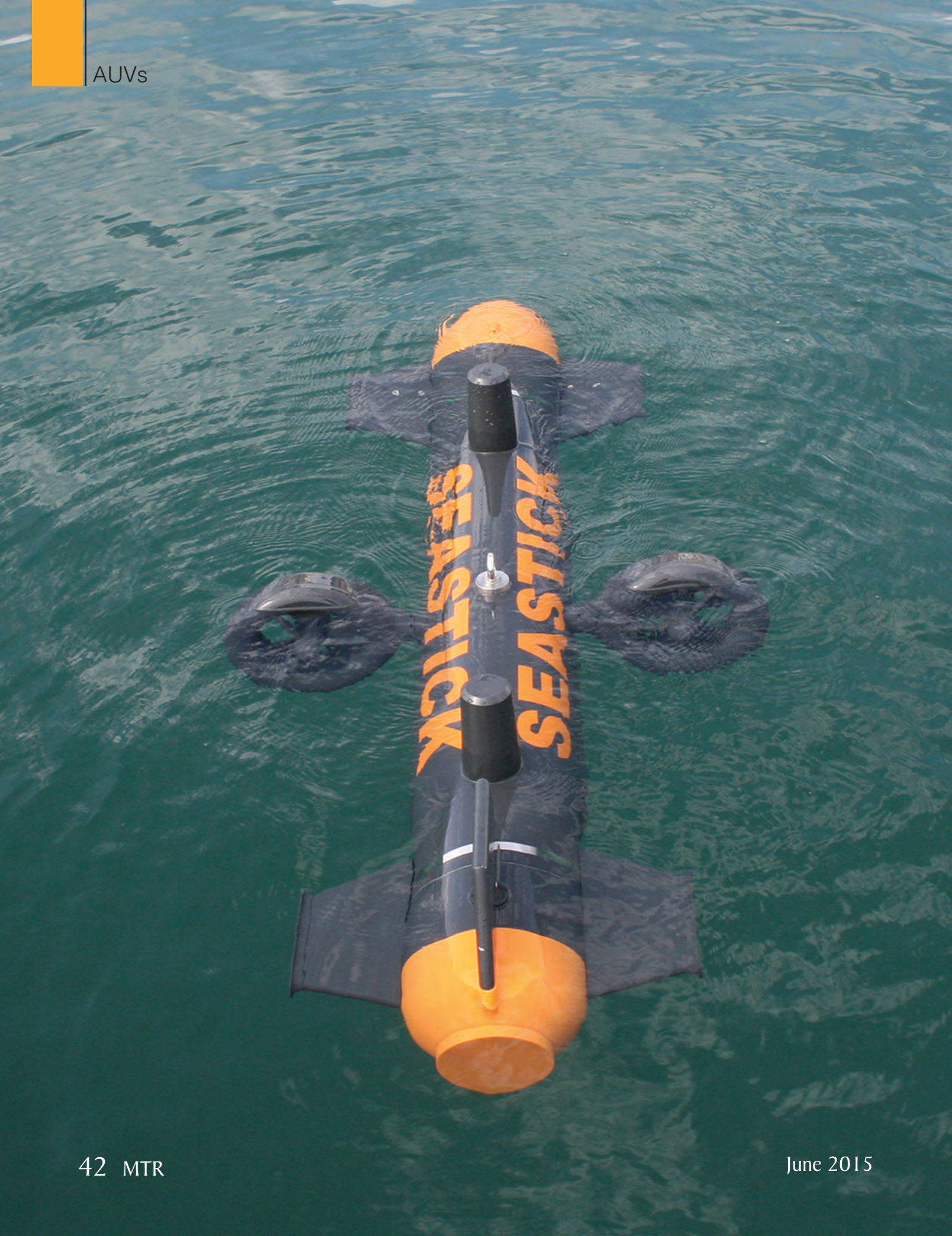
What do you envision will be the greatest challenge in bringing this vehicle from reality to market success?

The challenge is to educate people about the advantages of using autonomous vehicles. The market is quite con-

servative and new technology takes a while to become understood and the advantages apparent to the customers.

Can you discuss how Sailbuoy is currently active in the world?

We have had a number of mission over the years, one in particular would be the Gulf of Mexico mission conducted by Met.no and the Universtity of Talahassey March – May, 2013. This mission lasted for two months and where surface temperature, salinity and dissolved oxygen measurements were made. This was a scientific mission where 1) the validity and usefulness of Sailbuoy measurements and the instrument's utility in evaluating fields produced by different ocean models and 2) the potential of the Sailbuoy for mapping a large-scale river plume, which would be challenging or costly with conventional ship surveys and/or remote sensing were demonstrated.


SEASTICK
SEASTICK

Meet the Seastick

Roaming the tents on the National Oceanographic Center in Southampton on the occassion of Ocean Business 2015, we came across a new AUV design out of Italy. As one might expect with its pedigree, it is all black and stylish. Its designers contend that the beauty of SeaStick is far more than skin deep. We caught up with Roberto Nardini for some answers.

By Greg Trauthwein, Editor

Hailing from Italy, the story of the development of the Seastick, a new autonomous underwater vehicle (AUV) for the subsea market, starts the same as a great number of other stories told in this indsutry: Built with a generous mix of experience and wisdom with some of the best up and coming bright minds. Nardini explains.

"We are a team of mostly young people (everyone in the technical staff is under 30 years of age) that, combined with the experience of our CEO, who spent his whole life working in the submarine technologies field, is able to handle such a massive project like the Seastick. Every one of us comes from very different fields of studies: physics, mechanical engineering, electronical engineering, marine biology. That makes us a very flexible team and let us face many problems with ease, and is in this flexibility that lies our true strength."

Part of the flexibility of the new design comes courtesy of its capability too, designed as a vector capable of being able to mount any type of sensor according to customer request, thanks in part to its modular design which provides the possibility to expand and enhance the basic configuration.

And while Seastick is new, the concept is ripe, as it has been in development for eight years, with more than three years of sea testing under its belt before making its market debut last year.

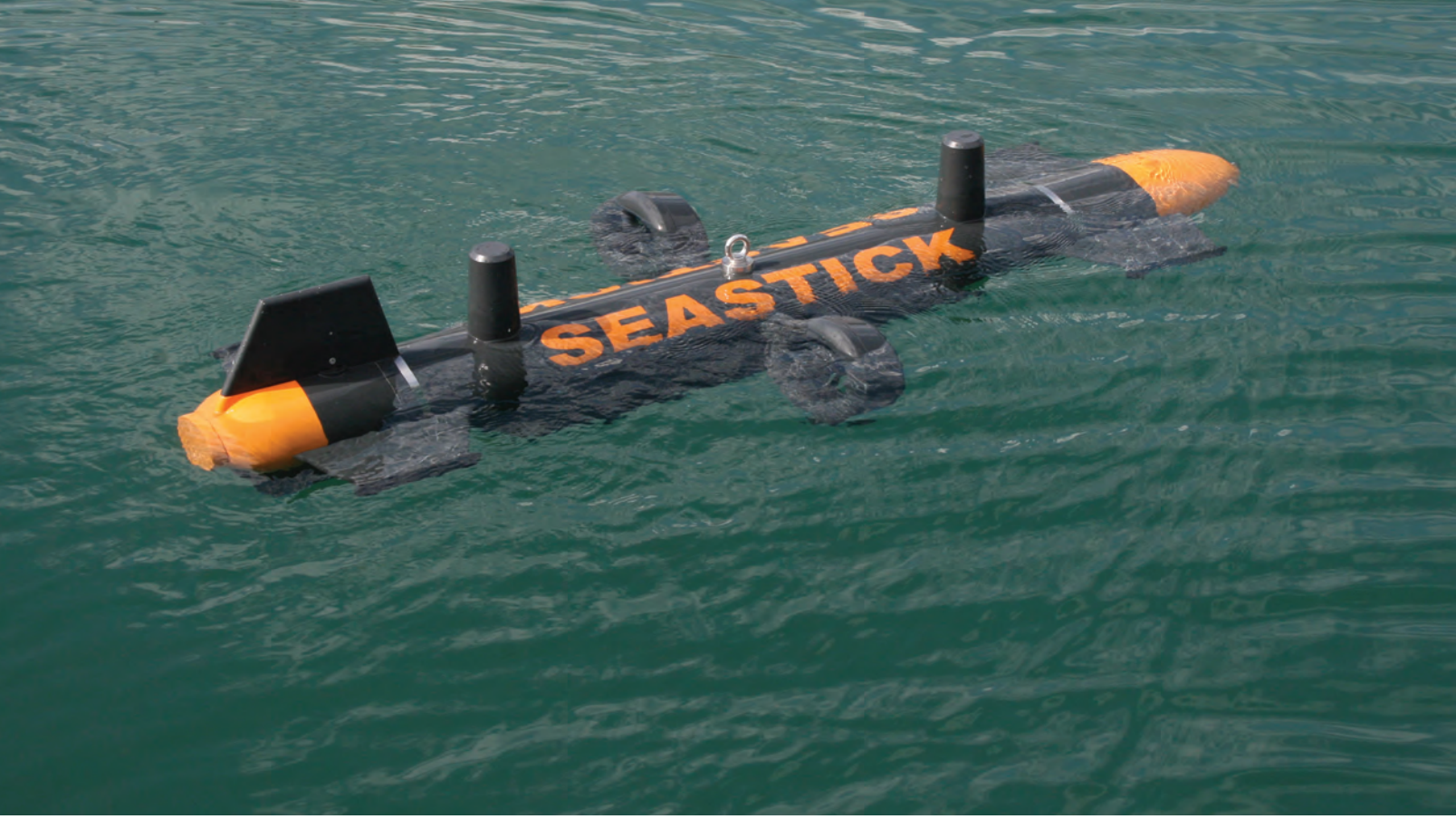
From the Beginning

Development of any technology is a perilous path from design sheet to market, particularly in an ever-crowded subsea vehicle field. But every system has its limitations, and Seastick was designed to address problems in the market with an innovative solution. "When the Seastick Project started, our aim was to create a compleately modular vehicle capable to integrate any kind of sensors with the maximum flexibility and very easy of use," said Nardini.

"Our aim is to improve the possibilities of action and usage of a basic autonomous underwater vehicle. In the past years we developed a great experience in the ROV and AUV market so we know what the problems of dealing with such vehicles are, in a practical way and not just in theory, and we are trying to make them less problematic. That's what was on our mind: to keep everything as simple as possible, even in a such complicate field such as underwater robotics."

To that end, Seastick is designed to work in almost every field an AUV could work, for both civil and a military uses. According to Nardini, a key design diffentiator is its dual control method. It is possible to operate the vehicle in automatic mode, by loading a mission made through its mission planner software, and it is also possible to operate in manual mode through Wi-Fi while on surface and through umbilical cable while submerged, making it behave like a ROV.

"Often, to keep things smoother and more simple you need some new technology, since the old one isn't suitable for that purpose," said Nardini. "That's why we have to develop new technologies that suit our needs. And that's how our motors were born. We needed a piece of equipment capable of being more efficient than the usual motors, something that would allow the Seastick to make some maneuvers that were impossible until now. Seastick can hover, turn around his own axis, do omnidirectional movement and variable steering angles. It



can also do a spin!"

And proving that old can be new, the developers are using a Wi-Fi system for the remote control of the vehicle and for the downloading of data in real time."

"The actual panorama in the AUV market is not properly varied," Nardini assesses. "We designed the Seastick thinking about something unseen till today, and we are very satisfied with our result. Our system is different from other AUVs, starting with its shape and including the usage methods and the possible uses. We think is a good time to invest in this project because is something completely different from the other vehicles."

Challenges Ahead

Even the best laid plans face challenges aplenty, and this is not the exception for the developers of Seastick. "Our greatest challenge was, and still is today, making the Seastick fully customizable and modular, to make it able to mount every type of sensors," said Nardini. "At the beginning of our project that was our biggest problem: every sensor needs a specific support and a proper wirework. It also needs its own software integration in a way that comply with the previously installed sensors. So the difficults came from both the mechanical and the software sides. We solved all of our mechanical problems by using a 3D printer. With this solution we can design and print all the supports we design making us independent from other manufacturers and allowing us to design and build all the specific supports we need quickly. It also allows us to make specifics flotation chambers in order to improve and calibrate the buoyancy of the vehicle."

In addition, Nardini admits that the software side is the most energy and time intensive part of the process in the making of a Seastick.

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DREDGING MEGA PROJECTS

According to the International Association of Dredging Companies' (IADC) Dredging Figures 2013, the global dredging turnover grew nearly 3% in 2013, nearly hitting the $13 billion mark. More significantly, even in bad economic times the industry recorded solid growth. Growth of 13% to be exact, from $11.4 billion in 2008 to $12.97 billion in 2013. Following is a statistical abstract of the most recent data from the world of dredging. IADC celebrates half a century with the publication of a special limited edition book, 'Beyond Sand and Sea.' Full details can be found on page 49.

Drivers for Dredging

1. World Trade

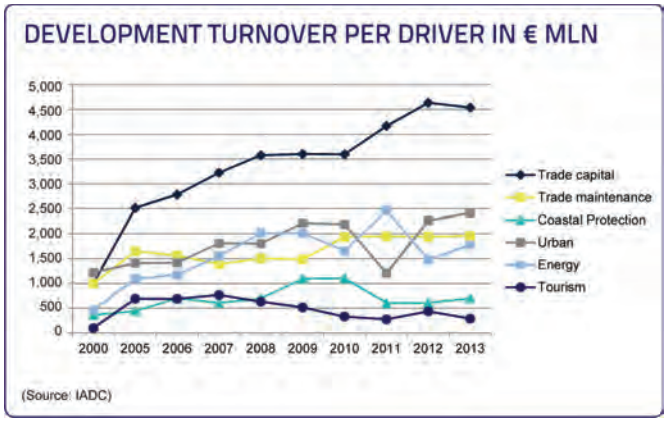
As the majority of the world's goods transport via ship, it stands to reason that dredging need correlates closely with world trade. Figure 1 indicates a long-term, positive trend in World trade more than doubling over the last 30 years. In addition, ships are getting bigger, and ports are becoming more snarled than ever. The need for dredging is central to maintaining and building port capability.

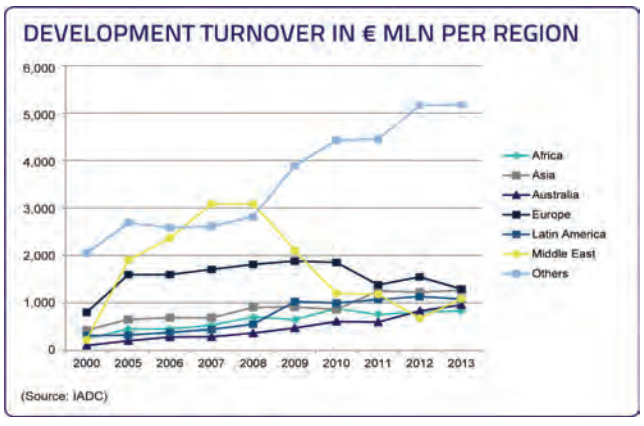
2. Urban Development

The world's population continues to grow, and so too does the push toward expanding population centers on the world's coasts. According to statistics cited in "Dredging Figures 2013," urbanized land is likely to double by 2030 as another 1.5 billion people migrate toward cities. In 1950 about 30% of the world's population lived in urban areas; today that number is 54%. In 2050 an estimated 66% of the world's population will live in urban areas.

3. Coastal Protection

Increasingly severe weather has put many coastal areas at heightened risk for significant damage from wind and waves when disaster inevitably strikes, as became alarmingly clear





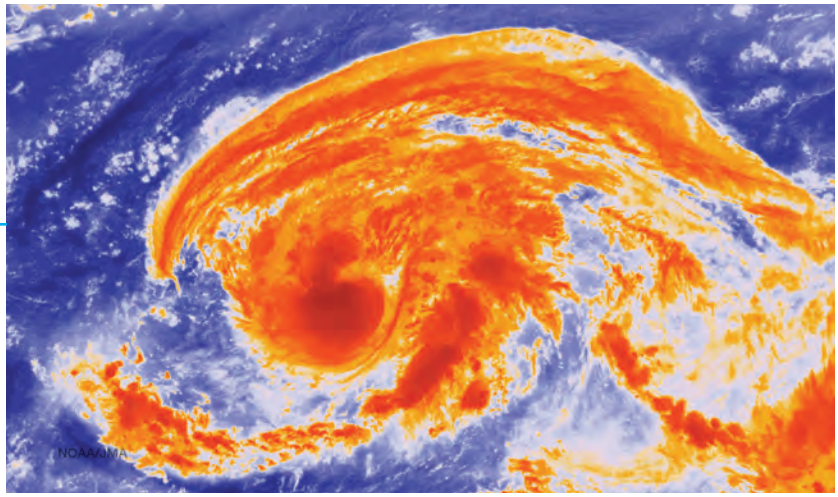
when Hurricane Sandy wrought damage in Manhattan in the autumn of 2012.. Dredging activities can go a long way in helping to shore up shorelines.

4. Offshore Energy

As population, Urban areas and world trade grows, so to does the need for Energy. It is estimated that 5% of the world's energy finds must be replaced every year, and increasingly companies are searching in deeper waters, further from shore, to score major new energy finds. This hunt for fossil fuels demands a lot of dredging, to prepare the seabed to digging trenches for pipeline and cabling.

5. Tourism & Leisure

Tourism along coastlines and beaches remains a growing phenomenon, from the small personal watercraft to the mammoth cruise ships roaming the world and further stretching port facilities and infrastructure. In addition, the replenishment of beaches from weather-related erosion is ongoing. But curiously, while tourism shows a steady growth of 4 to 5% over the last 5 years, dredging related to tourism has decreased from 4 to 3% according to Dredging Figures 2013.



EXPANDING PORT INTO THE NORTH SEA

1965 - 1973

The Netherlands / Maasvlakte 1

The first Maasvlakte extension at the Port of Rotterdam was built by a combination of dikes and sand suppletion reaching west into the North Sea. This expansion made it possible to receive larger ships and build numerous container terminals directly connected by train lines to the hinterlands of the rest of Europe, especially Germany. The extension also created space for the storage of toxic waste and polluted sand in an area called the Slufter and provided better protection for the environment.

30 MILLION CU. M.
OF SAND, SILT & CLAY

1977 - 1991
Belgium / Zeebrugge Harbour

Maritime extension works at the Port of Zeebrugge began in 1977 and continued for some 15 years. New breakwaters, improved slope protection, a sea lock and an LNG terminal at the port's eastern side were added. More than 30 million cu. m. of sand, silt and clay were dredged to create soil-substitution trenches, reclaimed terminal areas and to deepen the port basin for container and cruise ships. Finally, in 1991 the Albert II container quay wall and platform at the port's western end were constructed for a new container terminal.

30 YEARS OF DREDGING TRIPLES LAND SURFACE

1984 - 2012

Singapore / Jurong & Tuas

By the 1980s, after a decade of rapid industrialization, property on Singapore's mainland was scarce. A solution was found in the Jurong Island reclamation and Tuas extension projects. For 30 years since 1984, dredgers developed new land there. A plan to unite the 7 islets off Singapore's southwestern coast to form one island was implemented in stages. Started in 1995, Jurong Island was officially opened in autumn 2000, tripling the land surface of the original little islands. Together Jurong and Tuas form the new industrial zone of Singapore, with 987 hectares for the construction of a petro-chemical complex.

WORLD'S LONGEST (33.9KM) DIKE

1996 – 2010

South Korea / Saemangeum

The 33.9-km-long Saemangeum Sea Dike – the longest dike in the world – links the cities of Gunsan in the north and Buan in the south. Before construction of the dike, two rivers, the Mangyeon and Dongjin, discharged directly into the Yellow Sea. Now these rivers flow into a 400-sq. km reservoir created by the dike. In the future this reservoir will be transformed into land equal to two thirds the area of Seoul to be used for agricultural, industrial, business, residential, wetland and ecotourism.

40 MILLION CU. M. OF SOIL & ROCK EXCAVATED

2005 - 2015
Panama / Panama Canal

One hundred years after its opening in 1914, extensive operations are taking place at the Panama Canal. While improvements have been ongoing, recent works encompass the construction of two major lock complexes at the Atlantic and Pacific entrances, widening of a 14.2-km stretch of canal to 225 m and deepening to – 16.3 m, and deepening of the Pacific entrance and southern approach channel. Some 40 million cu. m. of soil and rock have been excavated and 5 million cu. m. of concrete are being poured. The notoriously hard subsoil was drilled and blasted. In total 25 million cu. m. of Atlantic muck and Gatun rock were dredged.

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MakaiLay Suite for Cable Layers

Makai Ocean Engineering, Inc. said it continues to address issues experienced by the subsea power cable industry by enhancing submarine cable lay software, MakaiLay, and its desktop simulation sister product, MakaiPlan Pro. Specifically, three key features are being integrated into the Power Cable modules for each of these products that are built specifically for power cable installers:

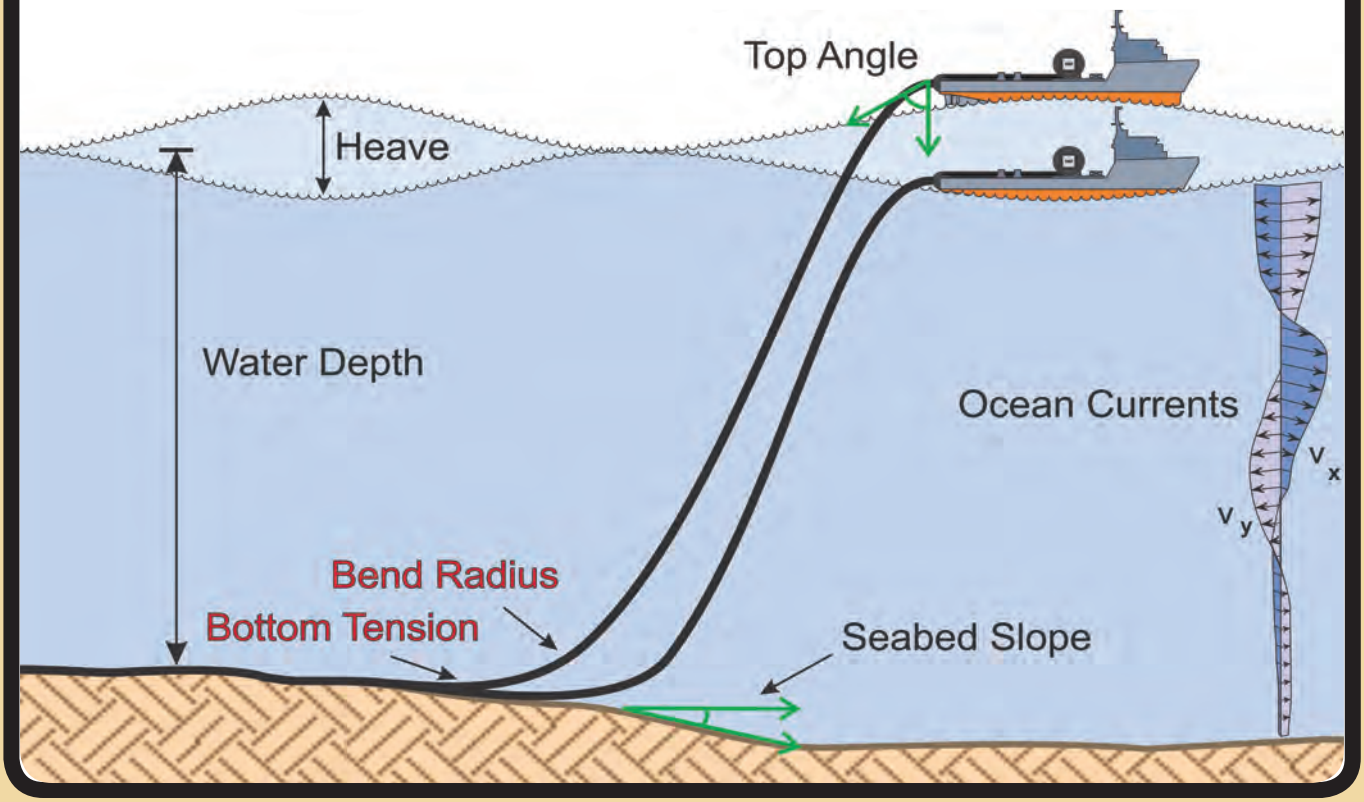
1. Cable Top Angle. MakaiLay now has the option to use the cable departure angle, or "Top Angle", which can be measured at the over-boarding point. When high quality measurements of top tension are not available, using the Top Angle enables Makai's real-time cable model to calculate cable shape, touchdown and tension more accurately during shallow water power cable installations. Makai has developed a new cable model that includes cable bending stiffness, which is now being used in two new tools: the Shape Calculator and the Heave Analysis tool.

2. Shape Calculator Tool. Allows the users to perform rapid static analyses of the cable shape under different lay conditions (currents, slopes, depths) to ensure bend radii and tensions are acceptable.

3. Heave Analysis Tool. Because power cables are laid with residual seabed tension, the cables' bend radii and tension are sensitive to heave of the ship. The Heave Analysis tool allows users to perform analyses for different sea states and lay conditions to ensure that tensions and bend radii are within allowable limits. The tool can be used in office to design a safe lay, or at-sea to make fast decisions about the lay as conditions change and contingencies arise.

The core product, MakaiLay, is designed to model the cable shape, bottom tension and touchdown location as it is installed on the seafloor. With a complete picture of cable conditions, operators can accurately control bottom tension and touchdown location, helping to reduce the time, cost and risk of a lay. For power cable jobs in areas of transition from shallow to mid and deep-water, steep seabed slopes and strong currents, it can become especially difficult to control the cable's tension and bend radius at the seafloor, risking the safety of the cable. In these situations, MakaiLay's cable control and navigation instructions become critical. The MakaiLay suite includes a route planning tool (MakaiPlan) and a simulating/training tool (MakaiPlan Pro), in addition to the real-time, at-sea tool for controlling cable deployment (MakaiLay). Power cable modules with a growing number of power-cable-specific features are available with each product.

www.makai.com



teledyne impulse

Teledyne Impulse

Teledyne Impulse designs and manufactures electrical and optical interconnection systems, motorized power transfer switches and custom insert molded compression connectors for a broad range of harsh environment applications. The company's products are used for applications including oceanographic wastewater management. From miniature underwater sensor connectors to ROV connectors, to the largest extremely rugged vehicle systems, Teledyne Impulse has created many solutions for subsea interconnect. By using standard products and custom engineered designs, Teledyne Impulse offers a widerange of application specific connection systems.

www.teledyneoilandgas.com

umbilicals intl.

Umbilicals Intl.

Cable and umbilical manufacturer Umbilicals International, acquired in March 2015, is now a Seanamic Group Company along with offshore handling specialist Caley. UI offers a range of compact, highly portable intervention workover and control systems; dive bell handling solutions including all types of diving umbilicals; ROV deployment systems: fixed and portable A-frame, and diverless recovery.

www.seanamic.com

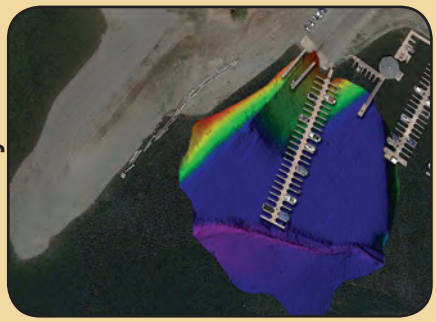
Remote Controlled Multibeam Survey

seafloor systems

Provider of specialized survey equipment to the hydrographic and geophysical survey community, Seafloor Systems, Inc. has released its EchoBoat-RCV remotely controlled survey vessel with integrated multibeam echosounder. Following testing and trials, the EchoBoat multibeam system is now available for purchase and rental to conduct high-resolution surveys for inspection, engineering and construction projects. The system can be operated from shore with remote desktop control to enable the user to calibrate the system as well as carry out accurate and detailed hydrographic surveys.

www.seafloorsystems.com

seafloor systems



2G Robotics & QINSy

2G Robotics said that the ULS-500 underwater laser scanner is now compatible with the QPS hydrographic data acquisition, navigation and processing software, QINSy. The QINSy suite can be used for various types of surveys, ranging from simple single beam surveys up to complex offshore construction works. With underwater laser scanning becoming the new standard for pipeline survey and inspection, QPS recognized the demand for QINSy to be able to generate similarly corrected and geo-referenced point clouds on-the-fly for laser systems when interfaced with GNSS and INS sensors.

Underwater laser scanning enables detailed inspections to be easily conducted and highly accurate measurements to be instantaneously and repeatedly captured from the 3D point cloud visualizations generated by the scanners. The laser scanners can be deployed by ROV or AUV and provide millimeter-level resolution point cloud data that far exceeds the resolution of sonar.

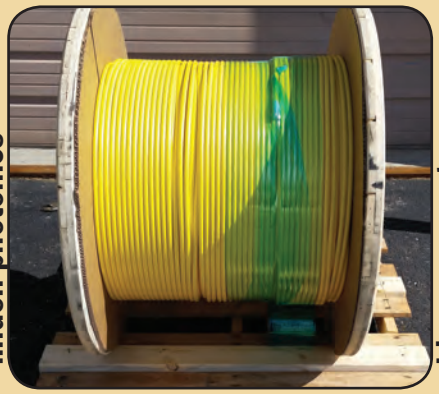
www.2grobotics.com / www.qps.nl

(Image courtesy of 2G Robotics)

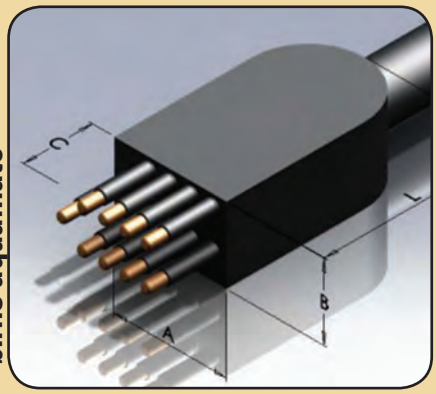
3D point cloud model of an ROV cage from the structure inspection demonstration.

birns

linden photonics



birns aquamate



BIRNS

The BIRNS Millennium series is a high performance, high density dry-mate connector range suitable for deep submergence applications to 6km depth. This series can be used with solid (molded) or oil-filled cables in straight or 90° configurations, and is available in high and low voltage, coax, fiber-optic, and hybrids of electro-coax, electro-optical and electro-opto-mechanical configurations.

Pictured here are BIRNS custom oil filled right angle cable assemblies featuring BIRNS Millennium size 3O connectors, each with eight 16AWG and nine 22AWG electrical contacts. The oil filled assemblies feature a unique double-ferrule electro-hydraulic connector adaptor system with two small rings, one on top of the other, that together formed a gentle wedge. When pushed down by the main nut, the rings gently but securely press against the tubing, which is supported internally with a stainless steel tube insert, thus sealing and retaining it.

The keys on the series are fully machined, as opposed to press fit, and feature a squared silhouette, providing maximum strength and making the keying process more seamless, secure and user-friendly. Users have the option of a third key, providing purposeful incompatibility of different positions between the same connector with different circuits.

www.birns.com

Linden Photonics

Linden Photonics introduces hybrid cables to its expanding product line. Building upon its STFOC cables whose pedigree comes from a long history and variety of underwater uses - from munitions tethers to ROV controls to littoral water sensing. Linden's Hybrid cables combine copper and fiber elements in a lightweight, yet strong and robust tether cable. Linden can customize a size, buoyancy and strength; from neutrally buoyant designs to extremely thin cables with various conductor offerings and fiber types available. Linden's patented cable jacket construction is designed to protect the fiber in the harsh subsea environment.

www.lindenphotonics.com

Geospace Offshore

Geospace Offshore designs and manufactures cable and umbilical products for the oilfield and remote operated vehicle (ROV) service industries and for specialty cable markets. The company's manufacturing facilities in Houston, Texas, produce technically sophisticated and highly reliable cabling and umbilical solutions for electrical, fiber optic, electro-mechanical and electro-hydraulic applications. Geospace said its one-of-a-kind layout and custom machinery in its manufacturing facilities is regionally unmatched, and its plant is located just 90 miles from the U.S. GOM.

www.geospace.com

BIRNS Aquamate

BIRNS Aquamate LLC manufactures underwater electrical connectors, cable assemblies and cable terminations for offshore diving, oceanographic, seismic exploration and defense applications. The company produces a range of standard industry connectors such as the 5500 Series, SC, MC, LP, FAWL/FAWM and Rubber Molded. The firm also produces custom designs for special connector solutions.

BIRNS Aquamate Connectors are suited for medium power or signal use, or when weight and/or mechanical abuse are considerations. This series is molded of high-insulation neoprene that may be mated while wet or underwater. Aquamate connectors are also suitable for most nonmagnetic requirements. Circular and Low Profile formats are available, as are our Mini-Connector and Flat (FL) and FAWL designs. Male and female connectors are available in bulkhead and in-line configurations. Heat-treated beryllium copper sockets, gold plating and stainless steel bodies are standard; options include water-blocking and locking sleeves of durable Delrin or heavy-duty Stainless Steel.

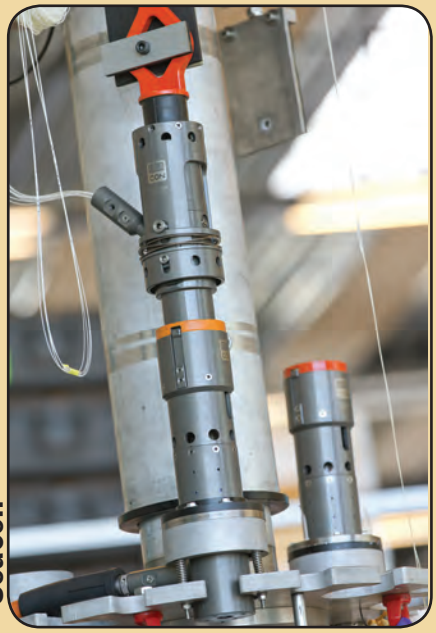
www.birnsaquamate.com

Seacon's Micro WET-CON

SEACON has added a range of split connectors to its Micro WET-CON wet mateable series. This series of connec-

tors was originally developed to provide all the features of the ALL-WET connector range, but in a miniature industry standard configuration. Split series enables multiple connectors from multiple instruments to be connected to a single bulkhead connector. The product is wet mateable and is available in six configurations ranging from six to 16 contacts. Key features include up to 10,000 psig (approx. 22,500ft/7,000m) mated, up to 600 VDC amd up to 19 amps max current. Typical uses are diver comms, UWTV, lights and ROVs.

www.seaconworldwide.com



Seacon

Seacon's Hydralight

The HYDRALIGHT is a second generation underwater mateable, high integrity, fiber optic connector. This 8 channel, oil filled pressure balanced connector is fully qualified to 7,000m, with an average single mode insertion loss of less that .2dB and a average single mode back reflection of -50 dB. With a design life of 30 years and a life cycle of a minimum of 100 mate/demates, this connector meets the following specifications: Norsk Hydro NHT-

In-situ Subsea Cable Repair

(Photo: N-Sea)

IMR specialist N-Sea used a wet repair habitat to complete an in-situ subsea cable repair. The habitat was developed by Moyle Interconnector Ltd. as part of the seabed repair project, with ESB International the owner's engineer for the project. The habitat allows repairs to be implemented in-situ below sea level, as opposed to the conventional method of recovering the subsea cable prior to repair. The diving scope was performed as part of a Moyle Interconnector project to carry out the repair on the Moyle Interconnector cable, a 500MW HVDC electrical interconnector, in the Irish Sea. The interconnector cable links the electricity grids of Northern Ireland and Great Britain through submarine cables running between converter stations at Ballycronan More in Islandmagee, County Antrim and Auchencrosh in Ayrshire. The fault area was located approximately 2.5km from the Scottish coast and submerged between one and three meters below the seabed, in approximately 25 meters of water. Explaining the technology and design behind the product, **CEO Gerard Keser (pictured above)** said, "The principle employed by ESB International is based on an incubator design which surrounds the cable section whilst providing a dry and conditioned repair option. We deployed our TUP Diving System (Transfer Under Pressure) along with one of our subsea support vessels, the Siem N-Sea, which allowed the cable to be repaired in its current position."

www.n-sea.com

152-00073 Rev 04H, Statoil TR1233, Elf Exploration AO-32-2-011-LT-00-SN-005 Rev C, Total GSEPSPS021, and BP GP78-21. Typical uses include high speed communications, long-distance, production control, pumping systems, sensing systems, Riser and PRM systems.

south bay cable

South Bay Cable

From the drawing of the copper rod to the jacketing of the finished cable South Bay Cable has a variety of cable manufacturing equipment to perform many operations.

The group's specialty equipment includes stranders, insulating and jacketing extruders, taping lines, striping machines, small and large planetary cablers, armoring machines for steel, serving lines for aramid fibers as well as considerable additional equipment required for the manufacture of specialized cable products.

Insulating and jacketing materials include PVC, PE, PP, FEP, TFE, TPR and PU. In addition to extruded versions taped constructions are also available.

Electro-Mechanical constructions include stainless steel and other high tensile materials in the form of braids, round wire armor and central strain member cores.

Buoyant or lightweight cable constructions include aramid fiber and other high tensile fibrous materials. Buoyant and neutrally buoyant cables are designed for underwater pressures up to 600 PSI using foamed materials, cables required for greater depths use pressure resistant materials such as thermoplastic rubbers to add buoyancy

Fiber optics are processed in several different configurations including tight buffered constructions reinforced with aramid fiber and fiber optics encapsulated inside hermetically sealed stainless tubes. Both the plastic and stainless steel techniques have been incorporated into numerous designs and subjected to cyclic and tension testing. During production there is negligible attenuation increase in the fibers; this is true for both single mode and multi-mode fiber optics.

www.southbaycable.com

Seacon

CS-MS' Range

The CS-MS connector range was designed for ROV applications. It has high density contact patterns and uses aluminum shells as standard in an effort to keep both size and weight to a minimum. The standard connector is also designed to be used with field configurable oil filled hoses for mission flexibility and quick field service. Open face rated as standard.

TE Subcom

TE SubCom's "Open Cables" is a new business model that allows customers to select preferred Submarine Line Terminating Equipment (SLTE) line card supplier to create an interoperable and complementary dry and wet plant. SubCom will continue to offer and invest in its advanced SLTE product line, in addition to the new Open Cables alternative, to provide customers with ultimate flexibility.

The Open Cables model provides SubCom customers greater choice and flexibility in choosing line cards while continuing to benefit from the company's latest technology. The Open Cables model takes advantage of fundamental facts in coherent technology together with transmission properties of high dispersion fibers in undersea systems. These fundamental principles allow the wet plant to be optimized regardless of the line card provider. Purchasers now have a cost effective, comprehensive yet bespoke solution that allows for a multi-vendor supplier base for transponders.

www.te.com

hydro group

Hydro Group

Hydro Group plc designs and manufactures subsea Underwater Mateable Connectors to client specifications, stating it can design Underwater Mateable Connectors for any underwater application. Its lineup includes both metal keyed and rubber keyed underwater matable electrical connectors, EExd and EExde Explosion Proof Connectors, Environmental Electrical Connectors, as well as Fiber Optic Connectors and Penetrators.

www.hydrogroupplc.com

nexans

Nexans

Temporary site cables are custom-made, quick-connectable cables for temporary use in the high-voltage network, for example, during repair work on overhead lines or in transformer stations when converting networks. The cables feature multi-strand copper conductors with cross-sections of 150 sq. mm and 300 sq. mm and are similar to high voltage cables, but the high-purity insulation allows for a reduced insulation thickness. This results in a compact cable with reduced outer diameter and weight. Temporary site cables are supplied with flexible pre-fabricated and pre-tested silicone rubber terminations which facilitates use in any position. The cables are available in 110, 132, 150 or 230 kV and are produced in lengths of 50 m to 500 m. They can carry a current up to 750 A and can be connected in parallel to double the capacity.

www.nexans.com

Outland Technology

Louisiana's Outland Technology designs and manufactures a range of video and audio products for the marine, military and industrial markets using high volume components adapted for specific applications. Its cables offering includes C-2300C, multi conductor cable for all cameras; C-3100, Neutrally Buoyant, Multi conductor cable for all cameras; and C-3400, Neutrally Buoyant, Multi conductor cable for the Outland 1000 ROV.

www.outlandtech.com

Teledyne Cable Solutions

Teledyne Cable Solutions, an alliance formed of Teledyne Storm Cable and Teledyne VariSystems, provides bulk wire and cable, and custom overmolded cable assemblies to the oil and gas, marine, defense, and transit industries

Teledyne VariSystems

VariSystems produces overmolded cable assemblies for harsh environments, serving the defense, mining and exploration industries. Teledyne VariSystems said its polyurethane cables and molded cable assemblies are as much as five times stronger than other (PVC) cable products, with as much as 30 times higher abrasion resistance while still offer superior flexibility and performance in extreme weather. The group also offers engineering, CAD service, expedite services and logistical support

Teledyne Storm Cable

Storm Cable, located in Dallas, is a vertically integrated manufacturer of cable and cable assemblies for demanding industries such as Subsea and Marine, Defense, Medical, Oil and Gas, and Industrial. Storm Cable utilizes a variety of components, materials and capabilities to formulate solutions in the harshest and most critical of environments, addressing issues from electrical to environmental performance, to flex-life and cosmetics. Our bulk cable and cable assembly capabilities provide application specific problem solving, working with your engineers to address individual projects or whole-system requirements.

www.teledyneoilandgas.com

Editorial Calendar

MARINE TECHNOLOGY REPORTER

Issue	Editorial	Bonus Distribution	Ad Close
January/ February	**Underwater Vehicle Annual: ROV, AUV, and UUVs** **Market:** Subsea Engineering: Oil & Gas **Tech:** Harsh Environment Systems for Arctic Ops **Product:** Scientific Deck Machinery	**Arctic Technology Conference** March 23-25, Copenhagen, Denmark **Subsea Tieback** March 3-5, New Orleans, LA	January 21
March	**Oceanographic Instrumentation: Measurement, Process & Analysis** **Market:** U.S. Navy Strategic Initiatives **Tech:** Ocean Business 2015 Technology Spotlight **Product:** Sonar Systems & Seafloor Mapping	**Ocean Business** April 14-16, Southampton, UK **Sea-Air-Space** April 13 - 15 National Harbor, MD	February 18
April	**Offshore Energy Annual** **Market:** Seismic Vessels & Systems **Tech:** Deepwater Positioning, Mooring & Anchoring **Product:** Subsea Vehicles and Systems for Pipeline Survey & Inspection	**Offshore Technology Conference** May 4-7, Houston, TX **AUVSI 2015** May 5-7, Atlanta, GA	March 27
May	**Underwater Defense** **Market:** Offshore Renewable Energy: Wind, Wave & Tide **Tech:** International Naval Technologies **Product:** Remote Sensing & Environmental Monitoring	**MAST Asia** May 13-15, Yokohama, Japan **UDT** June 3-5, Rotterdam, NL	April 24
June	**Hydrographic Survey** **Market:** Comms, Telemetry & Data Processing **Tech:** GPS, Gyro Compasses & MEMS Motion Tracking **Product:** Interconnect: Underwater Cables and Connectors		May 27
July/ August	**MTR100** **The 10th Annual Listing of 100 Leading Subsea Companies** **Market:** Offshore Europe Tech & Trends	 **Offshore Europe** September 8-11, Aberdeen, UK	July 21
September	**Ocean Observation: Gliders, Buoys & Sub-Surface Networks** **Market:** Oil Spill Monitoring & Tracking Systems **Tech:** Seafloor Engineering & Remote Operations **Product:** Geospatial Software Systems for Hydrography	**OTC Brazil** October 26-29, Rio de Janeiro, Brazil **SeaTech Week** October, Brest, France	August 21
October	**AUV Operations** **Market:** Research Vessels **Tech:** ROV Technology: Workclass to Micro Systems **Product:** Underwater Tools and Manipulators	**Oceans 2015** October 19-22, Washington DC **SNAME** November 4-6 Providence, RI	September 25
November/ December	**Subsea Engineering & Construction** **Market:** Fresh Water Monitoring & Sensors **Tech:** Offshore Inspection, Maintenance & Repair (IMR) **Product:** Underwater Imaging: Lights, Cameras & Sonars	**Underwater Intervention 2016** New Orleans	November 26

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- range: up to 8000 m
- accuracy: up to 0.04 degrees

LBL POSITIONING SYSTEMS

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To learn more about our products and services, visit us at f-e-t.com/subsea.