MARINE TECHNOLOGY REPORTER

October 2016

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Mission to Jupiter

"To Boldly Go Where No AUV has Gone Before"

View from the Top

Ian Jordaan

Promising Future of

AUVs Under Ice

From Micro to Work Class

ROV Technology

Volume 59 Number 8


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Ungava Bay
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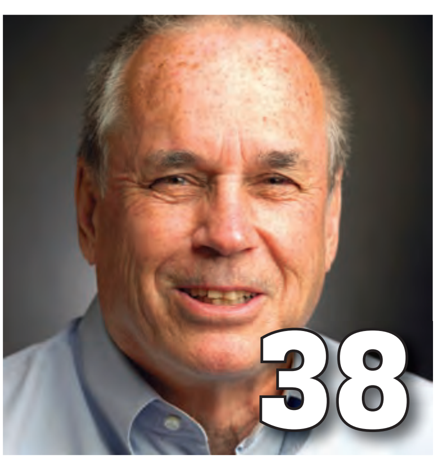

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AUVs are **Out of this World**

Gregory R. Trauthwein
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I know all too well the common refrain: 'we know more about the surface of Mars than we do about the subsea environment of our own planet.' But you must admit – even the most seasoned industry veterans that have 'been there, done that' – the prospect of sending an AUV 365 million miles away to explore beneath the ice on Jupiter's moon Europa is a fairly amazing proposition. This month **Kira Coley**, in her traditional excellence, delivers insight and images from inside the Europa-Explorer project as engineers seek to solve one of the greatest challenges ever. The mission, if it ever comes to fruition, is a more than a generation away to start. But if you start drilling down on the details regarding the problems that must be thought, re-thought and solved with triple redundancy, it is fairly mind-boggling:

- landing the space capsule on Europa;
- drilling a hole in an ice cap estimated to have a thickness between 2 to 9 miles;
- deploying an AUV to explore an ocean with an estimated depth of 62 miles!

The beauty of this project, whether it happens or not, is that the high level of intensive studies should have a measurable, positive impact on AUV design, construction and performance.

Kira's story, which starts on page 22, is just the tip of the iceberg in regards to subsea vehicle coverage in this edition. Starting on page 33 **Peter King** writes about the 'Past milestones and promising future' of *AUVs Under Ice*. King is a coordinator of the Australian Maritime College's AUV Facility, and he takes an insightful look at the rich history and rapid developments underway today. The ice theme is continued with **Andrew Safer's** one-on-one with **Dr. Ian Jordaan**. I leave it to you to turn to page 38 to get the background on Dr. Jordaan's substantial 'ice' experience, but suffice it to say his impressive background and affiliation with Memorial University lend substance to his expertise on the matter. Our final vehicle focus is by **Rhonda Moniz**, who takes a look inside the booming ROV market. This is Part 1 of a two-part series starting on page 46, and this month we look at developments among manufacturers of observational and inspection class ROVs.

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MacLeod
Ross MacLeod, Business Development Director at Ashtead Technology, joined Ashtead in 2011, bringing with him more than 30 years' experience in the oil and gas industry. After graduating from Robert Gordon University with an Honors Degree in Electronics and Electrical Engineering, Ross has worked as an offshore survey, ROV systems engineer and has held a number of senior technical and operational management roles.

Moniz
Rhonda Moniz has been in the Marine Technology industry for over 25 years. She has worked as a SCUBA instructor, scientific diver, dive safety officer, ROV pilot and underwater cinematographer. She has written for numerous publications and has worked on documentary productions for PBS and Discovery. She currently runs Underwater Investigative Group.

Safer
Based in St. John's, Newfoundland and Labrador, Andrew Safer writes about ocean technology and arctic expertise in the province for the City of St. John's Ocean Technology Media Program.

Forum: Order for Three ROVs

Forum Energy Technologies, Inc. received an order from New Orient Marine Pte. Ltd., to supply three remotely operated vehicles (ROVs) for its multipurpose ice-class vessel currently under construction in Singapore. The order includes two Perry XLX 200 horsepower, 4,000 meter Work Class ROV systems and one Sub-Atlantic Comanche 3,000 meter Observation Class ROV. Forum will also provide operation and maintenance training for New Orient Marine's personnel, as well as on board support during the ROV mobilization.

OceanServer Delivers

OceanServer Technology announced the continuation of a 10-year partnership with the launch of the next generation EcoMapper. The i3XO EcoMapper AUV is based on the Iver3-580 AUV platform and takes advantage of YSI's expertise in water quality solutions. The i3XO AUV utilizes the EXO water quality system to provide users high resolution water quality data, side scan sonar imaging, downward looking current profiling and an option for bathymetric surveying. Used by government agencies, military, universities, contractors and private organizations, the versatility of the i3XO system delivers a wide range of simultaneous monitoring capabilities. The new compact EXO design provides new EcoMapper customers up to eight water quality parameters (via four sensor ports).

(Photo: OceanServer)

General Atomics Battery for New Navy Submersible

General Atomics Electromagnetic Systems (GA-EMS) signed a contract with Lockheed Martin to provide Lithium-ion Fault Tolerant (LiFT) battery systems for use on U.S. Special Operations Command (USSOCOM) new Dry Combat Submersible (DCS), a long endurance delivery vehicle capable of transporting divers in a dry environment. The GA-EMS LiFT battery system will power the DCS propulsion and internal support systems.

Aker Solutions Shuffles Leadership Team

Aker Solutions is introducing a new executive management structure effective November 1, 2016. Dean Watson has been named chief operating officer. Watson joins from Schlumberger, where he has held various leadership positions, and will report to Chief Executive Officer Luis Araujo.

Schmidt Tests its New ROV in Guam

The new remotely operated vehicle (ROV) SuBastian is returning to shore after nearly a month of testing in the open ocean off the island of Guam in the western Pacific. Schmidt Ocean Institute (SOI) has been working this summer, testing and integrating its new ROV from aboard its 272 foot oceanographic research vessel Falkor. The 25-day testing placed ROV SuBastian in real-world conditions, demonstrating its functionality as a modern research tool with innovative systems. The ROV tests and trials included 22 dives and more than 100 hours underwater. Now that the vehicle has been tested, the team is working on making tweaks and improvements so that SuBastian is ready for its first research cruise later this year, visiting the Mariana Back-Arc in Guam. The 4K high-resolution video footage collected with SuBastian will be openly shared with scientists and interested public around the world. Schmidt Ocean Institute provides collaborating researchers and scientist's free access to research vessel Falkor, as well as expert technical support in exchange for a commitment to openly share and communicate the outcomes of research, including the raw observations and data. With many ROV research cruises foreseen through at least 2018, there certainly will be lots to learn with SuBastian.

(Photo: Schmidt Ocean Institute)

Data collected using SuBastian will be openly shared with the public and interested researchers. "This is just the start of SuBastian's life," said ROV Project Manager David Wotherspoon, "The team is incredibly focused and ready to put SuBastian to use. SuBastian will now be used by scientists to investigate the deep sea, acting as eyes, ears and hands miles beneath the ocean surface."

The other executive management team members were selected internally. Valborg Lundegaard, currently head of engineering, will lead the customer management center. Svenn Ivar Fure will continue to lead the company's front end efforts. Egil Boyum, currently head of the subsea business in Europe and Africa, will lead the products center. Knut Sandvik will lead the projects center, moving from being head of maintenance, modifications and operations. David Clark, currently regional head for Europe and Africa, will lead the services center. Svein Stoknes will remain as chief financial officer and Mark Riding will continue as head of strategy. Current head of subsea Alan Brunnen and head of operational improvement and risk management Tore Sjursen will remain at Aker Solutions through to the end of the year to assist in the transition to the new structure.

Seafloor Systems Expands Latin America Sales Team

Seafloor Systems appointed Mauro Romani as Sales Support Engineer for the Latin American market. Romani, who previously served as a Geotechnical Equipment Specialist for Golder Associates based in Lima, Peru, brings his experience into this new position, reporting to Josh Grava, Vice President of Sales.

(Photo: Seafloor Systems)

RJE Celebrates 25

RJE International, supplier of mission critical products for underwater navigation and aquatic safety applications, is celebrating 25 years in business. Pictured is RJE International CEO, Robert Jechart. RJE International has built a reputation as a manufacturer of quality and high-tech underwater products including diver navigation, diver sonar and underwater relocation products.

(Photo: RJE International)

A New UK Underwater Robotics Company

New subsea company Rovco has officially launched September 5 with the announcement of its first U.K. contract. An independent company focused on underwater integrity, remotely operated vehicles (ROVs), surveying and subsea services for both oil and gas, and renewables, Rovco has secured a contract with a U.K. Marine Trust.

Headquartered in Bristol, the privately funded organization aims to become a leading ROV and inspection company within the next three years, with expertise and capacity to carry out underwater inspection projects across the globe. The company is also about to embark on its second underwater survey project in partnership with a southwest diving company.

Led by chief executive and founder, **Brian Allen (pictured right)** Rovco will offer a high quality, cost effective solution for underwater hydrographic survey and inspection services, using high resolution state-of-the-art 4K cameras, and 360 degree scanning sonars.

(Photo: Rovco)

With more than 15 years' experience in the subsea industry, Allen previously managed multiple ROV systems on construction, inspection and lay vessels as a superintendent for Deepocean.

"After many years of working in the industry and being aware of how adopting new techniques could significantly reduce subsea operating costs and increase efficiency, I decided it was time to set up Rovco and do just that," Allen said. "Our independence, global capabilities and focus on subsea integrity will be what differentiates Rovco from what is currently being offered in the marketplace."

With a fleet of 10 ROVs, Rovco has the resources required to provide inshore/offshore services and inspections anywhere in the world.

Rovco is backed by Entrepreneurial Spark powered by Natwest, the free business accelerator program for new and growing ventures.

UXO Removed from German Offshore Wind Farm

James Fisher Subsea (JF Subsea), part of James Fisher and Sons plc, provided expertise for a project to locate, identify and dispose of deep-sea unexploded ordnance (UXO) at Nordergründe offshore wind farm located 16 kilometers off the North Sea coast of Germany.

Of the 224 targets identified, 72 were deemed to be UXOs and had to be detonated with minimal impact to sea life. JF Subsea's project manager, Max Clements, said, "Due to the project's potentially dangerous complexities- such as rough tide, heavily buried ordnance and inclement weather- the team was prepped to be ready at a moment's notice whenever a suitable weather window opened up."

(Photo: James Fisher Subsea)

Klein Promotes Kane

Joe Kane has joined Klein Marine Systems, Inc. as the company's new director of operations and manufacturing. He will be responsible for supply chain management, manufacturing and customer service.

(Photo: Klein Marine Systems)

New Executive Team at Liquid Robotics

Dr. David McLaren has joined Liquid Robotics as the company's new Senior Vice President of Engineering. In addition, Liquid Robotics has attracted other industry experts for strategic growth positions, including Mark Bindon, VP of Mission Services; Jerome Pereira, VP of Manufacturing; and Becky Tanner, VP of Marketing.

Seanamic Acquires IMES Ltd.

Surface to seabed company Seanamic Group has acquired the business and trading assets of IMES Ltd, an inspection and monitoring engineering solutions company headquartered in Aberdeen.

Silence Your Ships

By Dennis Bryant

Anthropogenic (manmade) sound is creating havoc among marine mammals and other aquatic species. These creatures have very sensitive hearing, which they rely on to find food and mates and (for some) to communicate and navigate. Sound waves can travel much further and with much less loss of strength in water than in air. In pre-industrial times, the oceans were relatively quiet. Sailing ships generated almost no subsurface noise. A whale's call could be heard by another whale hundreds of miles away in ambient conditions. The substantial and growing amount and volume of anthropogenic noise in the ocean comes from a variety of sources including commercial and naval shipping, fishing, recreational craft, sonar, seismic surveying, blasting, and marine construction. Due to the volume or energy levels at which sonars and seismic surveys (such as air guns) generate their sounds, these sources seem to have the greatest immediate impact on marine mammals. Other manmade sounds, though, have long-term impacts. Cavitation from ships' propellers now generate a ubiquitous level of noise in the ocean that can oftentimes mask natural sounds.

IMO

In 2012, the IMO adopted and made mandatory the Noise Code so as to reduce the level of noise exposure to individuals on commercial ships. The Noise Code had been preceded by noise guidelines. The Noise Code applies to new construction and the guidelines address conditions on existing vessels.

In 2009, an IMO Correspondence Group, chaired by the United States, submitted an extensive report on noise from commercial shipping and its adverse impact on marine life. In 2014, the IMO Marine Environment Protection Committee (MEPC) approved guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life. These guidelines focus on the primary sources of underwater noise – those associated with propellers, hull form, onboard machinery and operational aspects. They recognize that much, if not most, of that noise is caused by propeller cavitation. The guidelines also recognize that the largest opportunities for reduction of underwater noise will be during the initial design stage, but noise reduction is still possible for existing vessels, particularly on the occasions of propeller replacement and hull work, such as installation of a bulbous bow.

NOAA

Recently, the National Oceanic and Atmospheric Administration (NOAA) published an extensive technical guide for assessing the effects of anthropogenic sound on marine mammal hearing. For decades NOAA has been conducting analysis of the sources and impacts of manmade noise in the ocean. Those studies as well as numerous others from different sources reveal that the impact of manmade noise on marine mammals and other aquatic life is pervasive.

A wide-ranging NOAA report on anthropogenic noise in the marine environment, written in 2000, contains a detailed analysis of the sources of manmade noise in the ocean and its effects on marine mammals, marine fishes and other taxa (sea turtles, flora, invertebrates, and birds). It notes that 'quiet ship' technology has been developed but is not widely used by the commercial sector. That may be about to change.

NOAA is developing a plan for reducing anthropogenic noise in the ocean that includes proposals for rulemaking to require reductions in noise-making activities. Noise from some of these activities, such as marine construction projects, is currently regulated through the Marine Mammal Protection Act and its requirement for incidental harassment authorizations prior to commencement of projects that may result in the 'taking' of marine mammals. This requirement has not previously been imposed on commercial shipping.

The plan under development reportedly will call for developing noise limits for a variety of sources. Regulations could build on the 2014 IMO underwater noise guidelines and set design requirements for new construction, with limited retrofit measures for existing ships. Hopefully, any such steps would be coordinated worldwide through the IMO negotiation process.

Geographic Approach

More immediate, though somewhat geographically limited, steps could be taken in the same manner as is currently done with the critically endangered North Atlantic right whale (NARW). If supported by adequate data, which does not currently exist, underwater noise standards could be established for various sections of U.S. waters, based on the presence of certain marine life, particularly marine mammals. Ships would then be prohibited from transiting those waters while generating underwater noise above the designated level. This could force either speed reductions or the adoption of noise-reducing technologies.

While any unilateral approach adopted may be enforceable within internal waters and the territorial sea, enforcement of underwater noise restrictions against foreign vessels outside the territorial sea would be problematical without IMO cooperation. The IMO in 1998 adopted a mandatory ship reporting system requested by the U.S. government for ships transiting through waters off the east coast of the United States so as to reduce the risk of those ships striking NARWs. Subsequently, the IMO adopted or adjusted Traffic Separation Schemes (TSS) in these same waters so as to improve NARW protections. If presented with sufficient evidence and justification, the IMO may well support a mandatory underwater noise reduction measure.

What to do?

The marine industry should not wait to have external bodies impose potentially unrealistic standards on its operations. Rather, it should be proactive in the examination, development, and adoption of realistic measures to reduce underwater noise generation by ships. Owners should require that their new ships be designed to incorporate 'quiet ship' technology. Remember that it takes energy to generate noise. The less noise that a ship generates, the more efficiently it will be operating.

Photo: AutoNaut

Autonomous Boat Monitors Ocean Noise

Plymouth University Marine Institute scientists are working with AutoNaut and its nearly silent 5m wave-propelled USV, which tows a Seiche Ltd passive acoustic monitoring array, on a project studying how increasing levels of man-made noise in the sea is affecting marine life.

RV Meen Shandhani

Photos: IMC/Bangladesh Department of Fisheries

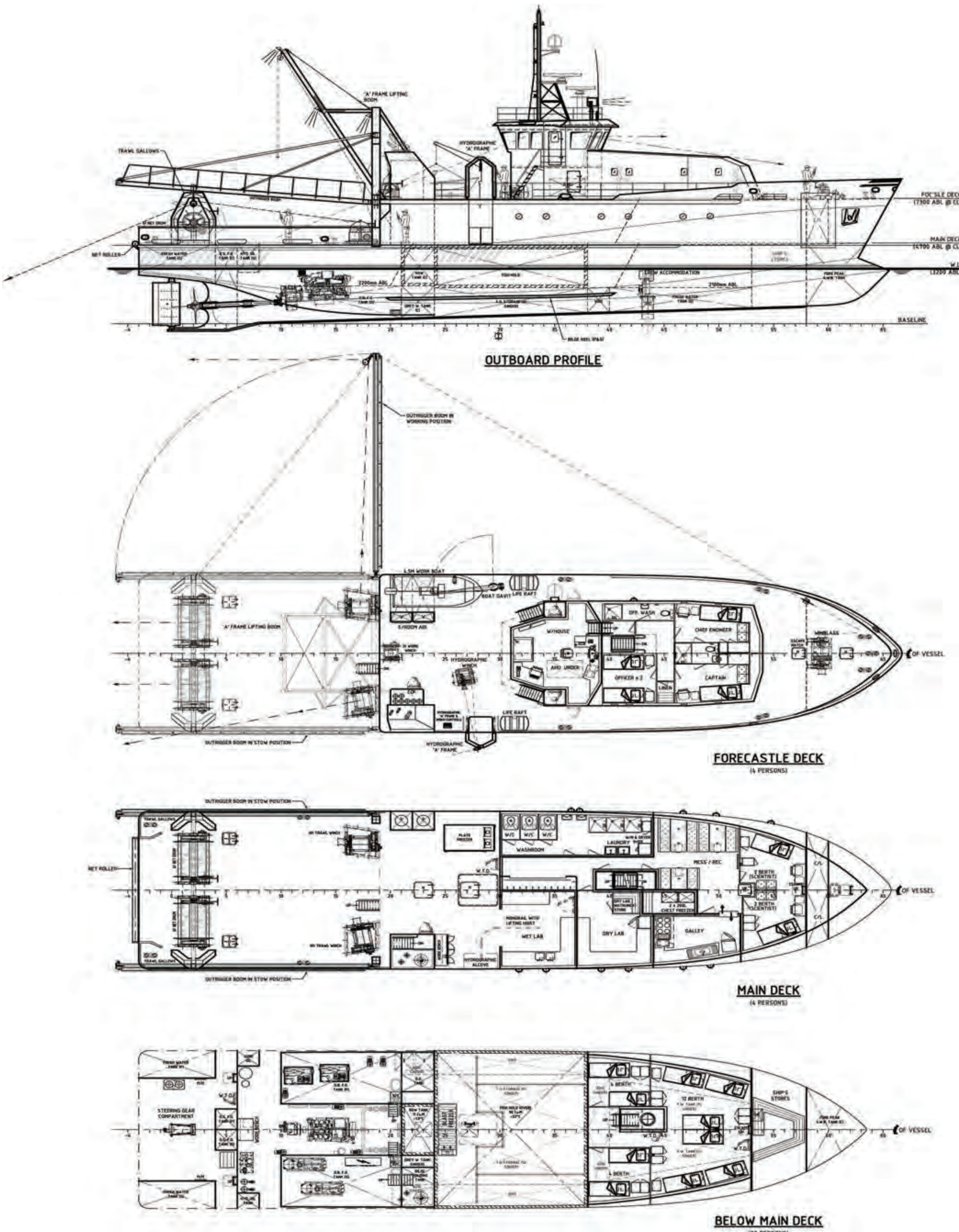
Photos: IMC/Bangladesh Department of Fisheries

FRV for Bangladesh

IMC's latest fisheries research and survey vessel design was built in Malaysia for the Bangladesh Department of Fisheries. RV Meen Shandhani arrived in Bangladesh in June after completing extensive sea and fishing trials and its delivery voyage. The Australian consultancy's naval architects and engineers drew on a wealth of relevant experience, data and expertise when developing the vessel's design. Formed in 1994, IMC and its principals have a long interest in, and association with, the fisheries sector. Managing Director Justin McPherson worked in Australia's Northern Prawn Fishery before training as a naval architect and the company's design library now includes projects covering longliners, purse seiners and pearling vessels, as well as research vessels such as the 35.8m RV Solander and 22.6m RV Naturaliste. IMC is currently finalizing a prawn trawler design to address the Australian fisheries' ageing fleets.

Built at the Sumber Samudra shipyard, the 37.8m Meen Shandhani is capable of mid-water, bottom and otter board trawling, as well as oceanographic research including sea bottom and water sampling. The main deck layout reflects these diverse capabilities, with a net roller, trawl gallows and twin 2,000m capacity single drum net winches, each capable of eight tons pull at 22m per minute, located aft to support stern trawling. Central to all trawling operations are a pair of trawl winches, each of which can store 2,400m of 16mm steel wire rope and provide 10 metric tons pull at 22.5m per minute. Bottom, mid-water and shrimp trawl nets are of Korean design manufactured in Malaysia by Jaya Nets, while the otter boards are from BMI in Korea. Forward of the trawl winches, beneath the shelterdeck, there is a stainless steel/aluminum semi-contact plate freezer to port, while IMC designed an alcove into the starboard side. The alcove enables specialist hydrographic tools such as conductivity, temperature and depth (CTD) packages and water sampling equipment to be safely deployed and retrieved, with lifting accomplished by a dedicated A-frame and hydraulic winch combination located on the deck above.

The equipment can be transferred into the purpose-designed wet lab immediately forward of the alcove using an overhead Toyo monorail and electric



Photos: IMC/Bangladesh Department of Fisheries hoist system. Further reflecting the important scientific and sampling work the vessel will undertake, a dry lab is located ahead of the wet lab. This space also includes a dedicated instrument store. The remainder of main deck is used for accommodation, with a large combined crew amenities and laundry space; galley; and mess/recreation space; as well as two cabins, each providing two berths for scientific personnel.

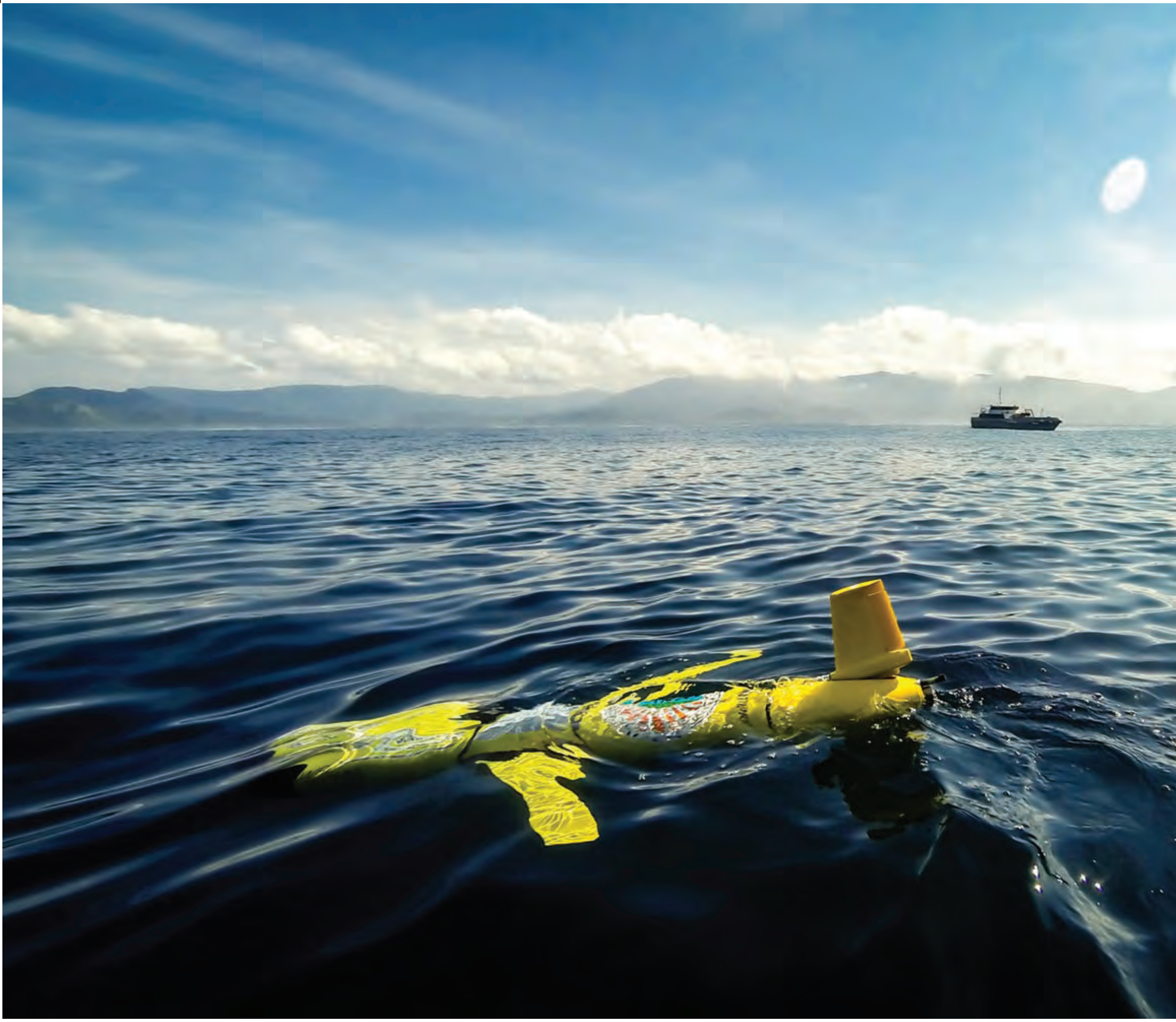
The shelter deck area also provides the access to the vessel's 90 cu. m. fish hold. Located just forward of amidships on the lower deck the hold can be cooled to -22°C. IMC's design also incorporates an 11 cu. m. refrigerated sea water (RSW) tank that can be maintained at -1°C. Bitzer compressors and condensers, and Desmi condenser pumps, are used for the RSW, plate freezer and fish hold refrigeration systems.

Aft of the fish hold are tank spaces, including double-bottom fuel tanks and the RSW tank, and the research vessel's large machinery space. Propulsion power comes from a single Cummins QSK38-M engine with the heavy duty rating of 1,400 hp at 1,800 rpm. This drives a fixed pitch propeller through a 6:1 reduction Hitachi Nico/Twin Disc MG-5506 gearbox. Mentrade supplied the propeller, stern tube, shafting and rudder package. Engine control and steering systems are from Kobelt.

The machinery space also houses a pair of 150kW, 50Hz generators powered by Cummins QSB7-DM engines and the two 75kW hydraulic power packs for the fishing deck equipment. A workshop area is located against the bulkhead that separates the machine space from the steering gear compartment, which also houses fresh water tanks port and starboard.

Navigation electronics are primarily Furuno (including X- and S-band radars, DGPS navigator, log, GPS plotter/echo sounder) with Raytheon Anschütz selected for the autopilot and GPS; Hapcon for the bridge navigation watch alarm system; and Haiyang for the AIS. Furuno also supplied a color scanning sonar and Doppler current indicator, while a Samyung unit was specified for the net recorder. The only exceptions to the use of Furuno communications equipment are the SARTs (Samyung) and EPIRB (McMurdo). A four camera HKVision CCTV system is also fitted.

Outside on the forecastle deck are the hydrographic winch and associated control station, plus a 4.2m Hwayan rigid inflatable work/rescue boat and associated davit. Meen Shandhani is classed by Bureau Veritas with I * Hull *Mach Special service / Research shipUnrestricted Navigation. Its steel hull has a molded beam of 9.2m, depth of 4.6m and design draft of 3.3m corresponding to a deadweight of just over 194 tons. It is expected to commence extensive fisheries resource surveys in the Bay of Bengal.



(Photo: Ashtead Technology)

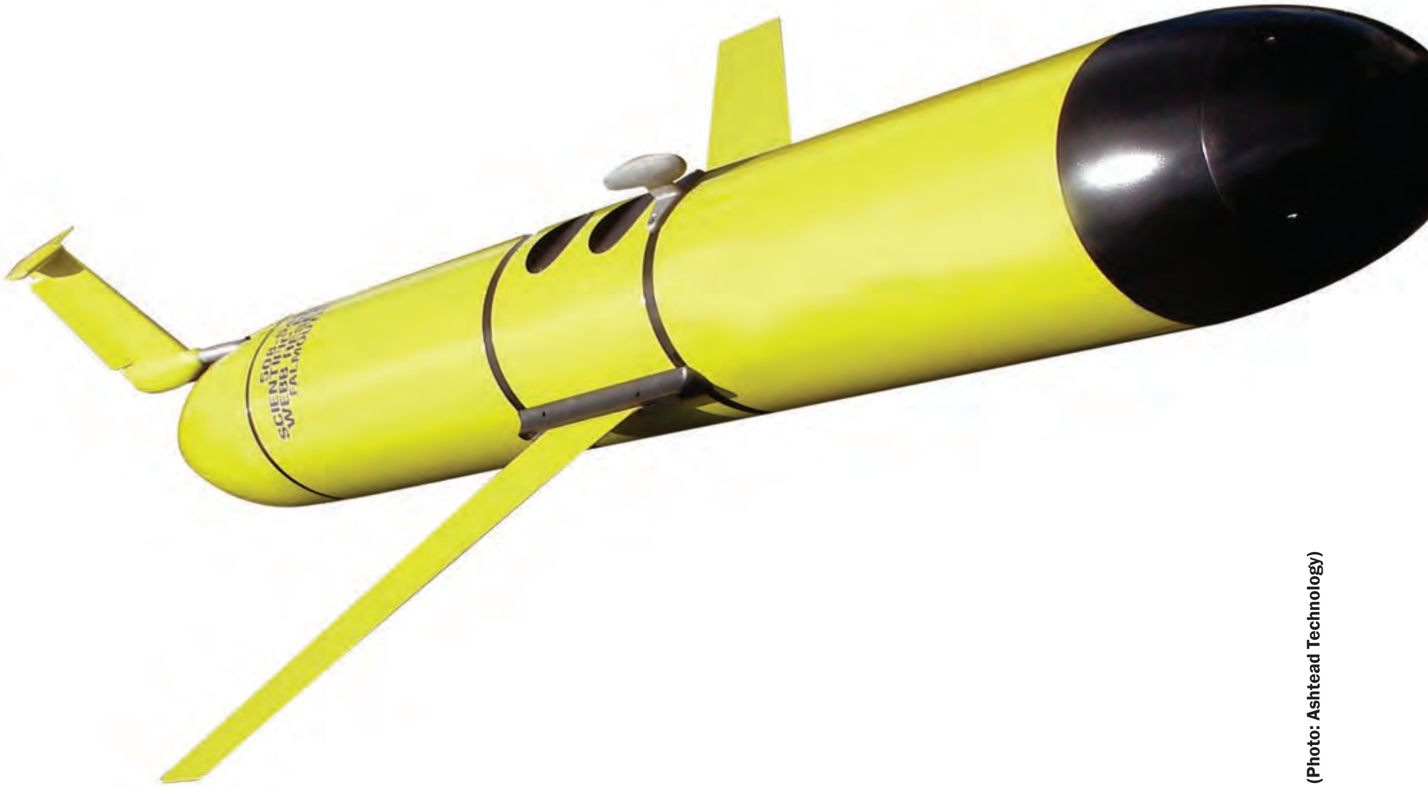
What Lies Beneath?
Subsea Industry to Delve Deeper with Underwater Robotics

By Ross MacLeod

Autonomous Underwater Vehicles (AUVs) and buoyancy-driven gliders have revolutionized the way the subsea industry gathers oceanographic data and despite the volatility of oil prices, it is predicted that the demand for this technology will continue to grow over the next five years and beyond. Although the sustained low oil prices have reduced budgets and put a cap on the development of new technology, operators are quickly beginning to realize the cost saving benefits of underwater gliders forcing them to rethink their approach to subsea exploration.

Saving Time is Saving Money

Gliders are the latest step in the development of autono-



(Photo: Ashtead Technology)

mous float technology. Unlike conventional propeller driven AUVs, they don't require a vessel on-site and can be deployed for up to six months without having to resurface. They are also much smaller and lighter, making them easier and quicker to transport and mobilize for international operations.

Historically, remote operated vehicles (ROVs) or divers have been used for underwater research activities, however these methods are far more complex and can take many weeks to plan and deploy, often requiring large numbers of personnel and big budgets.

In the current market where this is no longer a viable option for many companies, gliders ability to operate without human intervention, eliminating the safety risks attached to operating ROV vessels, makes them an increasingly attractive alternative to the subsea industry.

The first subsea gliders were highly specialized and were limited in scope to the specific task that they were designed to complete. Since then, technology has progressed allowing them to become dynamic platforms for a variety of imaging, chemical, biological, acoustic and oceanic sensors that can be adapted to meet the needs of a specific project.

During the 1990s, AUV technology entered an intense research and development phase which was largely funded by national defense agencies, with commercial vehicles not widely available until around 2000.

Today, with advances in technology, gliders operate with little or no need for powered systems and are typically used offshore to investigate environmental, metocean or water-mass structures.

Ashtead Technology, a leader in marine technology and subsea services, has been an exclusive distributor of Blue Ocean's fleet of Teledyne Webb Research Slocum gliders since striking a global asset management agreement last year with the provider of ocean data solutions.

Blue Ocean's Slocum gliders can be equipped with a diverse range of different sensors and can be deployed in the water for up to a six months at a time. With two-way satellite communications the gliders can be deployed and controlled anywhere in the world, are highly weather resilient and have no environmental impact.

Conceived by Douglas C. Webb and supported by Henry Stommel, Slocum gliders were named after Joshua Slocum, the first man to single-handedly sail around the world.

The long-range and duration capabilities of Slocum gliders make them ideally suited for subsurface sampling, they can be programmed to transmit their data to shore while downloading new instructions at regular intervals.

The small relative cost and the ability to operate multiple vehicles with minimal personnel and infrastructure enables small fleets of gliders to study and map the world's most dynamic seas.

Slocum gliders operate using buoyancy as a propulsion

Case Study

Blue Ocean Monitoring recently completed a contract in Indonesia working for PT Newmont Nusa Tenggara (PTNNT), which is a subsidiary of Newmont Mining Corporation, one of the world's largest gold producers with assets and operations across five continents. The task was to utilize the Slocum glider for monitoring in support of PTNNT's Tailings Placement Program at its Batu Hijau copper-gold mine in Sumbawa, Indonesia. The program involved tailings from the mine being piped (3.2 km) offshore and deposited off the continental shelf, where the depth reaches in excess of 4,000m. The glider equipped with a suite of water quality sensors was deployed to monitor the tailings which were not being disbursed into the coastal environment of Sumbawa. The monitoring program took just three weeks to complete and satisfied the full objectives of the survey scope.

mechanism, which allows for longer deployment periods and the collection of large datasets continuously over these extended time scales.

They are capable of transmitting data in real-time and can be deployed and recovered easily, at a fraction of the cost of traditional vessel-based or fixed-mooring monitoring approaches, lowering both project costs as well as health, safety and environmental risks.

Initially gliders were used extensively for academic and military applications but over the past few years, they have been increasingly adopted for a wide variety of oil and gas applications including pipeline leak detection, oil spill response, decommissioning studies, dredge/construction plume monitoring, environmental monitoring and metocean studies.

Over time gliders have become more and more autonomous with less human interaction required as artificial intelligence has advanced.

To meet the long-term needs of the subsea industry, current developments are focused on increasing battery life, improving autonomous functions and enhancing sensor capabilities so they can perform increasingly challenging intervention tasks.

This will see gliders play an important part in the dismantling of offshore structures as decommissioning activity steadily increases over the next decade.

They will also allow decommissioning work to be carried out as cost-effectively and safely as possible, either replacing or supporting ROVs and diving operations in monitoring and mapping the environmental impact.

It's believed that gliders will develop faster than the 30 years it took ROVs to become everyday tools, and with software and sensor improvements, they could truly transform the way the industry conducts underwater installation, inspection, repair and maintenance work.

The current generation of gliders are capable of exploring water depths of 1,000m, travelling at approximately 1-2 nautical miles per hour.

Future developments in glider technology could see them operate with long endurance, extreme depth, or rapid response capabilities, while development of new sensors will further expand the parameters that can be measured.

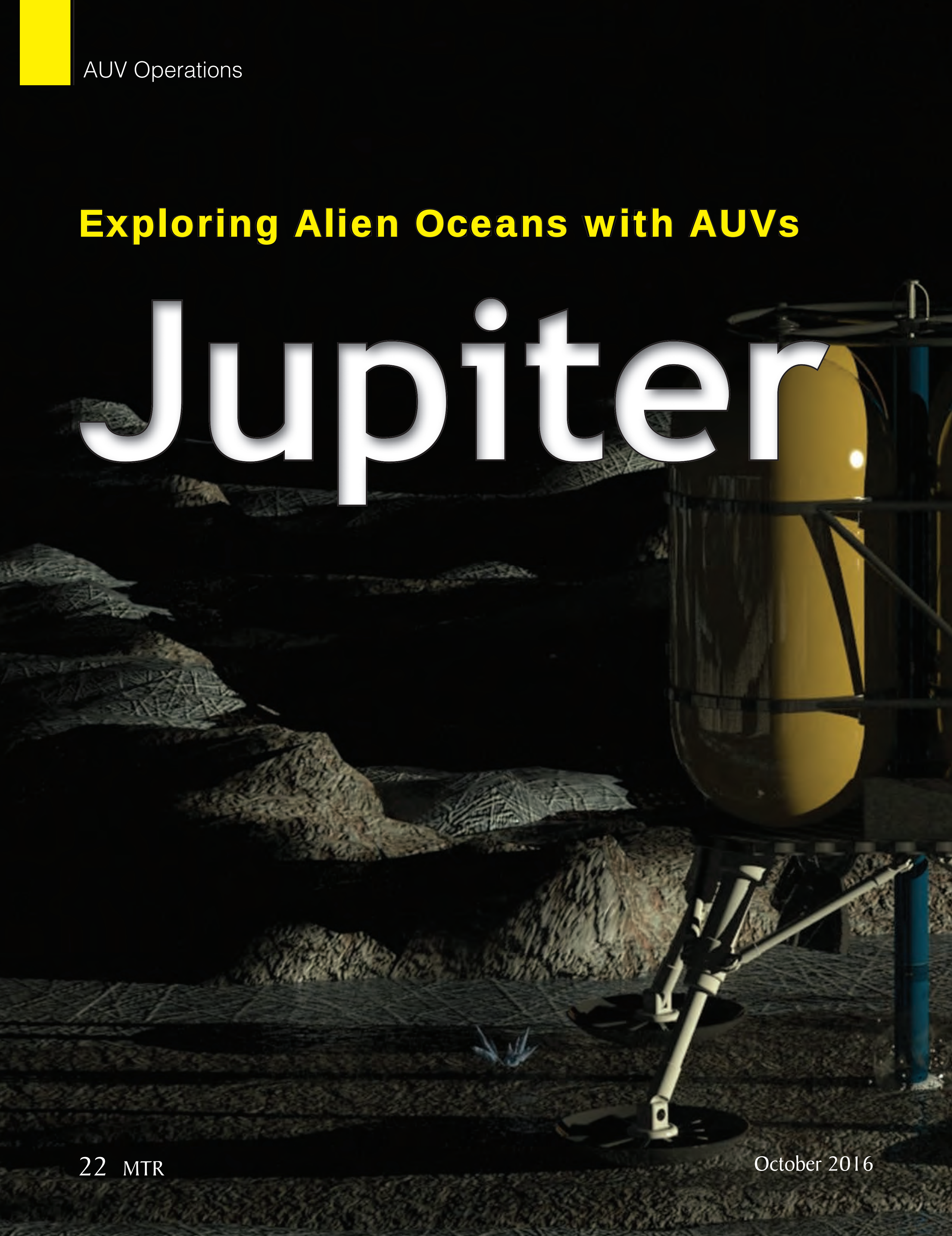
It is clear that gliders will continue to play an increasingly important role in the exploration and monitoring of the world's oceans.

Their capabilities have already surpassed what was once believed as possible, travelling across complex terrain to collect high resolution metocean data to satisfy monitoring requirements for a number of industries including subsea, offshore renewables, mining, engineering and environmental.

The continued development of gliders and sensors will increase the range of marine applications, while advances in artificial intelligence will increase reliability and flexibility.

Exploring Alien Oceans with AUVs

Jupiter



By Kira Coley

Shielded by a thick, brittle ice surface, a vast warm ocean hides beneath. Scientists consider Jupiter's smallest moon, Europa, to be the most promising for alien life and have set in motion multiple concept ventures to design an autonomous underwater vehicle (AUV) which could successfully explore this remote, off-world environment. Many Europa-bound missions are yet to come to fruition and prove the feasibility of this ambitious and complex task, until now. After four years of research and development, the Europa-Explorer project, engineered by Germany's Robotics Innovation Center (RIC), have built a working prototype submersible and a mission plan for perhaps one of the most exciting space exploration mission endeavors of our time.

Touching Down
Animation of the lander vehicle needed to deliver an AUV to explore Jupiter's moon Europa.
(Image: DFKI GmbH/ Meltem Yilmaz)

Easy as 1, 2, 3!

Docking the AUV subsea Europa is one of the many critical challenges of this mission.

(Images: DFKI GmbH/ Annemarie Popp)

Though smaller than the Earth's moon, Jupiter's moon Europa contains more liquid water than Earth. The unusual features of the fractured icy surface and discovery of the water plumes in 2013, add to scientific speculation that tidal heating may warm this voluminous saltwater expanse to temperatures favorable for life. Thought to have a thickness between 3 and 15 kilometers, Europa's ice surface shields an ocean, an estimated depth of 100km (62 miles) – the Mariana Trench, a shallow 11 kilometers (7 miles) by comparison.

While several spacecraft have already completed a mixture of long-term and flyby missions, 2030 will be the decade both NASA and the European Space Agency (ESA) launch further data-collection missions of Europa's environment and begin the search for life.

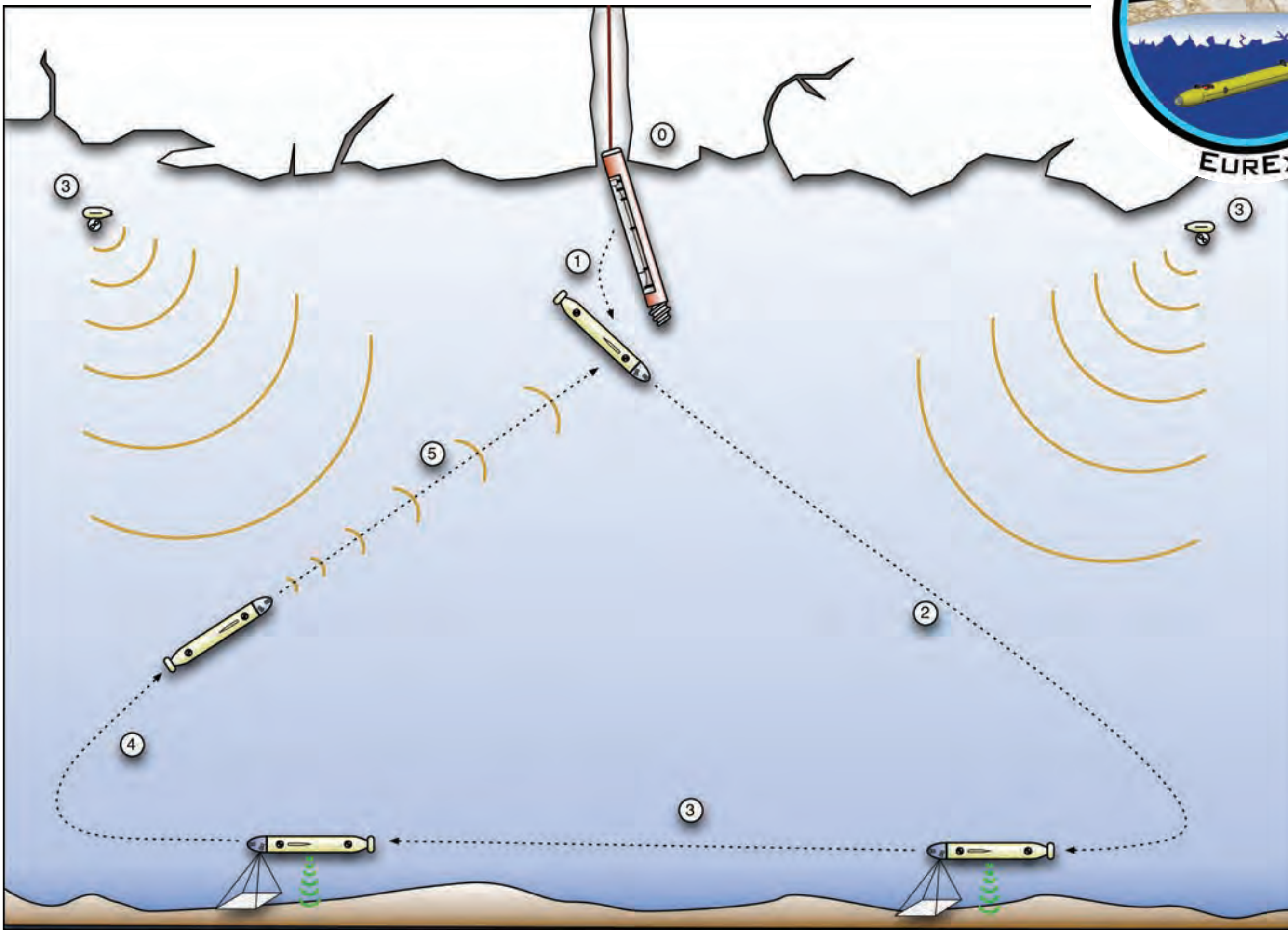
Mission Europa-Explorer

The German Research Center for Artificial Intelligence (DFKI GmbH) Robotics Innovation Center (RIC) launched the Europa-Explorer project in December 2012 – a pilot survey for future missions to Europa. It focuses on the aspect of navigation of robotic systems on and especially under Europa's surface. After four years of concept development funded by the German Ministry of Economics (BMWI), a possible mission scenario has been drafted which covers all aspects of exploration, from the time of landing until the transmission of data back to Earth.

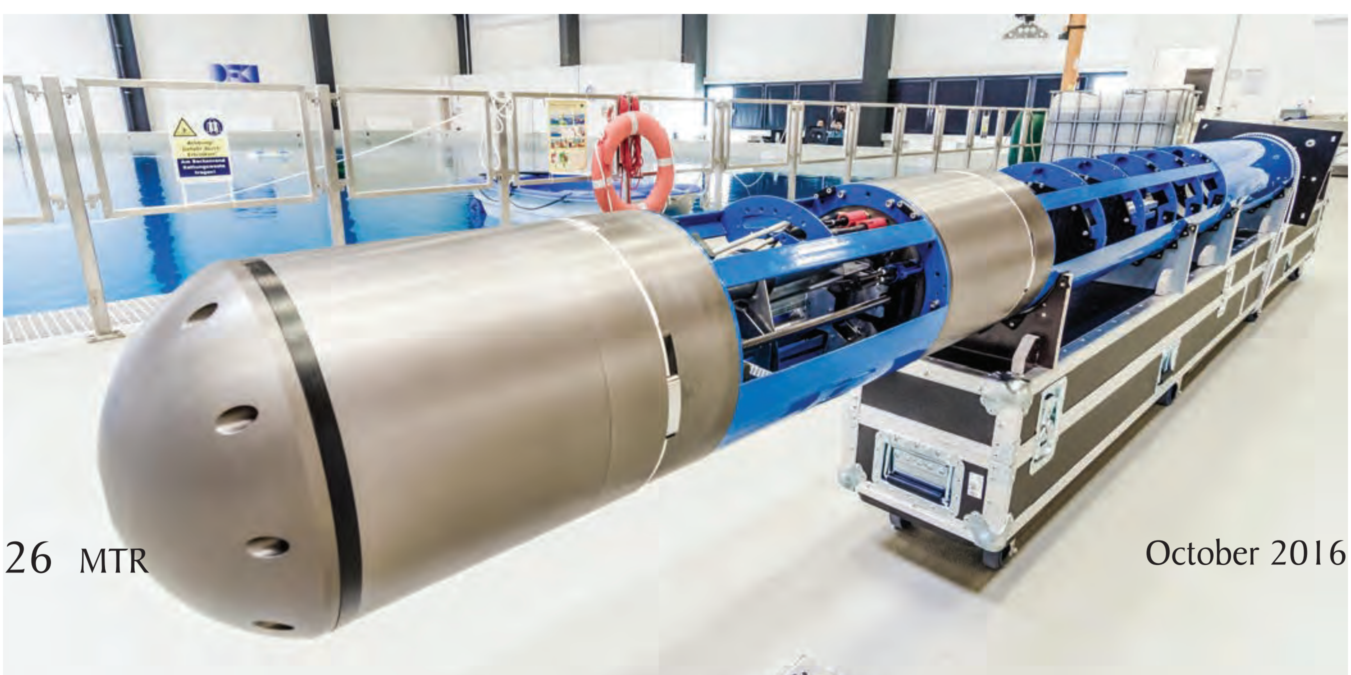
After arriving on Europa, the mission plan is to have a terrestrial "IceShuttle" melt a narrow passage through the moon's frozen shell. A swarm of micro gliders will be dispersed into the water, anchor themselves to overhanging ice, and begin transmitting acoustic signals. These signals will allow the AUV "Leng" to orient itself before descending into the depths of Europa's ocean. After completing fully autonomous exploration of the seafloor, Leng will return to the IceShuttle to dock, upload results, and recharge.

Dr.-Ing Marc Hildebrandt, Project Leader of Europa-Explorer and scientist at DFKI GmbH, explains, "The microgliders are one-way vehicles and will not return to the IceShuttle at the end of a mission. For their deployment, a passive system was devised which makes sure the gliders are deployed flying in separate directions. For the AUV, a lot of energy went into the question on how to deploy, dock and reintegrate a vehicle moving mostly horizontally into a vertically aligned IceShuttle. Our final concept utilizes the AUV's ability to change its buoyancy and by that its pitch angle. The docking itself is not that easy: unlike most AUV docking-systems it was not possible to deploy large cones for vehicle catching, making it a precision docking approach more akin to spacecraft dockings. We are very proud that this aspect is very robust and reliable."

The necessity for the development of



For the exploration of this vast expanse of water, a fully-autonomous system is necessary *because of the time it takes to transmit from Earth to Europa (33-53 minutes). While the AUV is submerged and un-docked no external control is possible, and scientists are still not sure what environment to expect.*



(Images: DFKI GmbH/Jan Albiez)

new systems lies in the level of specialization of the two components required for the mission. The autonomous ice-drilling shuttle with a payload system is a new area of research and not available off the shelf. The small, narrow 200mm diameter AUV is required so that the AUV fits into the payload section of the IceShuttle, adding further to complications in the design, along with highly-specialized sensors needed for the exploration of an under-ice foreign environment. Typical under-ice-exploration AUVs used on Earth are significantly bigger.

"If I had to select one single biggest challenge of this project it would be complexity. When starting the project 3.5 years ago, both the AUV and the IceShuttle were sketched as much simpler devices, which developed tremendously in complexity with each added environmental parameter, security issue or additional requirement. Another more expected challenge is the whole navigation. You can boil it down to this: 'after an exploration of unknown terrain find your way home to a 100km distant 30cm large hole.' That's quite a challenge."

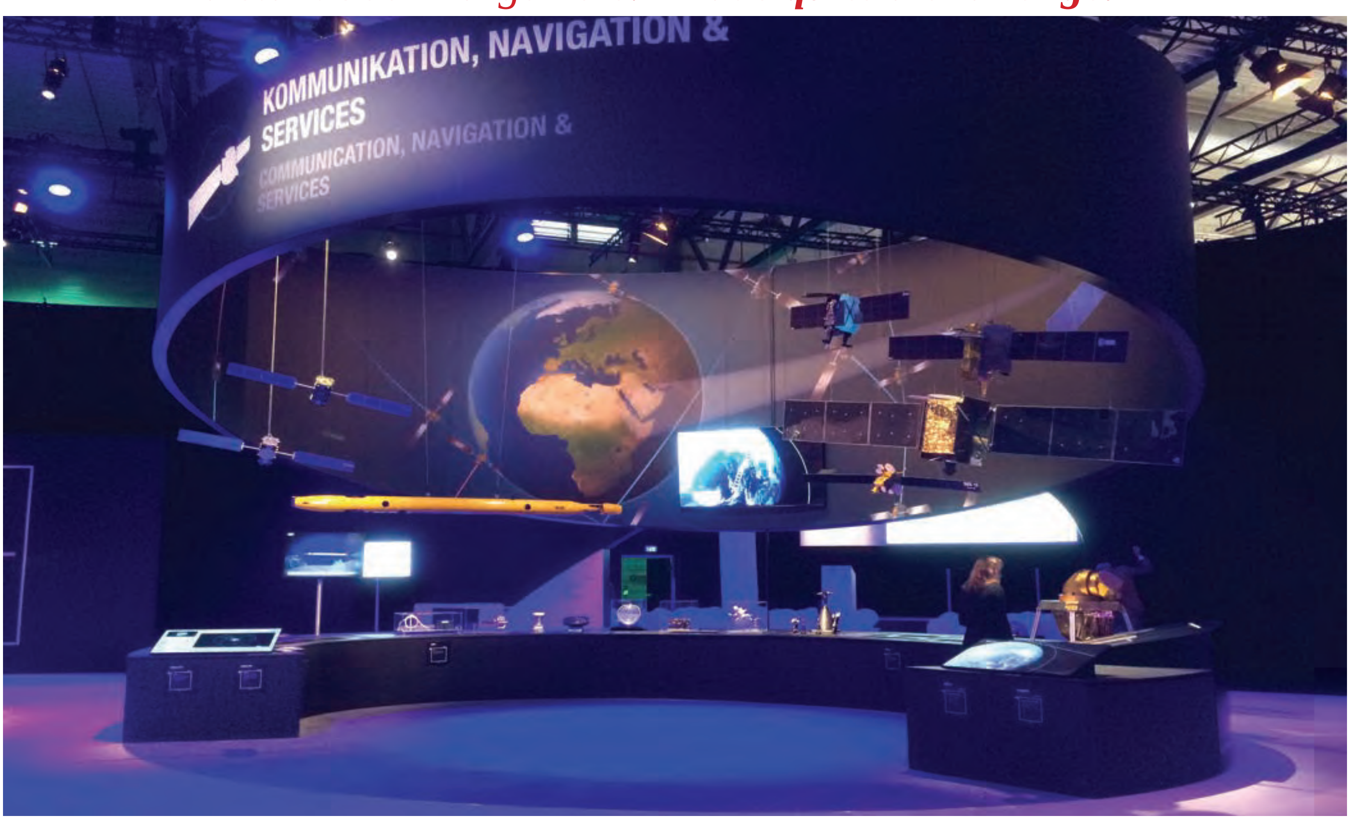
Into the Unknown

As engineers and computer scientists, the RIC project team did not have a comprehensive knowledge of Europa's environment, so they asked the experts: the researchers of the MPS, the 'Max-Planck institute for solar system research.'

Hildebrandt recalls, "They gave us a lot of details on what to expect but also cautioned that most of these facts are inferred and not yet finally proven, since no one, not even a probe or robot, has yet set foot, or wheel, onto Europa. The main facts for us are: there is liquid water with a certain amount of solved salts; there will be shallow currents at the equator, stronger ones at the poles; the ocean could be 100km deep which due to lower gravity conditions, resembles pressure conditions at the Marianna trench; and there will be a magnetic field, but Jupiter's magnetic field. One hypothesis – in fact one of the reasons this moon is so interesting – states, that there should be hydrothermal vents similar to the ones found on Earth. If the water is liquid, there has to be an energy source – this leads to the assumption of a hot core. If the right conditions could be found in the ocean, life may even exist there, similar to the sun-independent ecosystems around hydrothermal vents in our deep oceans."

For the exploration of this vast expanse of water, a fully-autonomous system is necessary because of the time it takes to transmit from Earth to Europa (33-53 minutes). While the AUV is submerged and un-docked no external control is possible, and scientists are still not sure what environment to expect. In addition to that, the necessity for the vehicle to dock

“Another more expected challenge is the whole navigation. *‘After an exploration of unknown terrain find your way home to a 100km distant 30cm large hole.’* **That’s quite a challenge.”**



(Images: DFKI GmbH/Andrea Fink)

with the ice-shuttle after each successful dive adds to this complexity. Although there are modern AUVs which can perform long fully autonomous missions, a system which "lives" in an underwater environment and monitored irregularly has yet to be shown in practice.

The primary design goal of the AUV was for it to fit into the IceShuttle: as the energy required to melt a hole through the ice increases quadratically with the diameter of the hole, the size of the IceShuttle should be as compact as possible, limiting the AUV to 190mm in diameter. While AUVs of similar diameters exist, such as Remus100 and Gavia, they do not have the extensive instrumentation required for a prolonged mission to Europa. Getting all these devices (DVL, ADCP, FOG, CTD, cameras, diving-cells and docking capability) into such a small diameter was a challenge for the RIC team.

'Leng' Phone Home

"One of the big paradigms we have is 'always be able to come home.' While this is evident in a typical mission situation, this ability is also a necessity if something went wrong – if a thruster malfunctions, a sensor does not work anymore or the battery is depleted faster than expected. A 'typical' AUV on Earth would surface and start sending out emergency signals using satellite communications. This is not possible on Europa, making the whole autonomy much more comprehensive. The vehicle must always have the possibility to go back to the IceShuttle, because if it can't then we can't communicate or update the mission, so the mission is lost. This is a top priority – if it sees the system isn't doing what it's supposed to do, then the vehicle will return to 'base' and report back to a human on Earth so they can take a look at it," explains Hildebrandt.

In the first project, CUSLAM, the team at the RIC designed and built an AUV, "Dagon", for scientific data collection and created a novel vision-based underwater localization system. The Europa-Explorer project, extends this localization system for the special environment of an under-ice long-range exploration as necessary to navigate on Jupiter's moon, Europa. This navigation system is unique, based on the Dagon AUV which uses stereo camera-based system with a 30cm baseline looking straight down at the ocean floor. The system was modified, taking into account the smaller diameter and, therefore, the reduced baseline of the vision-based localization system. By tracking features in the images, the vision system then can compute the vehicles motion and navigate by recognizing features on the seafloor which may appear uniform to the human eye.

A more extensive sensor package will be included at a later stage such as dissolved gas sensors (O2, CH4), fluorometry sensors, and micro-labs for amino-acid detection or character-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ization. The AUV will also need to withstand 1,100 bar external pressure, a feature also planned for a later date.

"For us, it was more important to be able to first show our ability to create a functioning, fully-autonomous team of robots which can execute complicated missions without human interaction. A similar reason is the usage of aluminum for the pressure hulls: the real vehicle will likely be manufactured from titanium alloys, but they would have been too expensive and not really necessary at the current project stage. An area where we tried to be as close to the real system was navigation – only sensors that would work on Europa was included in the system. This goes especially for devices such as LBL or compass sensors. An optical avoidance of sorts will also be used: a sonar will be doing avoidance and scanning for an obstacle in front of the vehicle but presently it only stops the vehicle if it becomes too near to the obstacle. We will want the full avoidance capability in the future for a long term mission which allows it to go around the object but at the moment the focus is long-term navigation and autonomy of the submersible."

Hildebrandt is confident that their concept will work and, after some refinement, succeed in exploring this off-world ocean. The next steps for the team are real-world testing of the instruments here on Earth: first on the 5m thick Arctic ice surface, then on the 100m thick Antarctic ice shelf, or perhaps subglacial lakes. If successful, the RIC team will begin planning for a "real" mission to Europa and seek collaboration with NASA or the ESA.

"As well as space, some people are interested in using this system on Earth. We have a lot of contact with the German Research Center for Arctic exploration, AWI, as they'd like to have a system to deploy in Antarctica for one-year, summer to summer, keeping the ice shuttle and AUV in the water for climate change research. This is not currently possible as AUVs can go down for a few days but always relied on being retrieved for recharging or mission updates which can only be done in the Antarctic summer. So, having something like this for a long term deployment is hugely beneficial to some applications, this just being one example. We are planning on using it on Earth as well as space. If we can prove we have a working system than the ideas of other scientists on how to use it will come quickly."

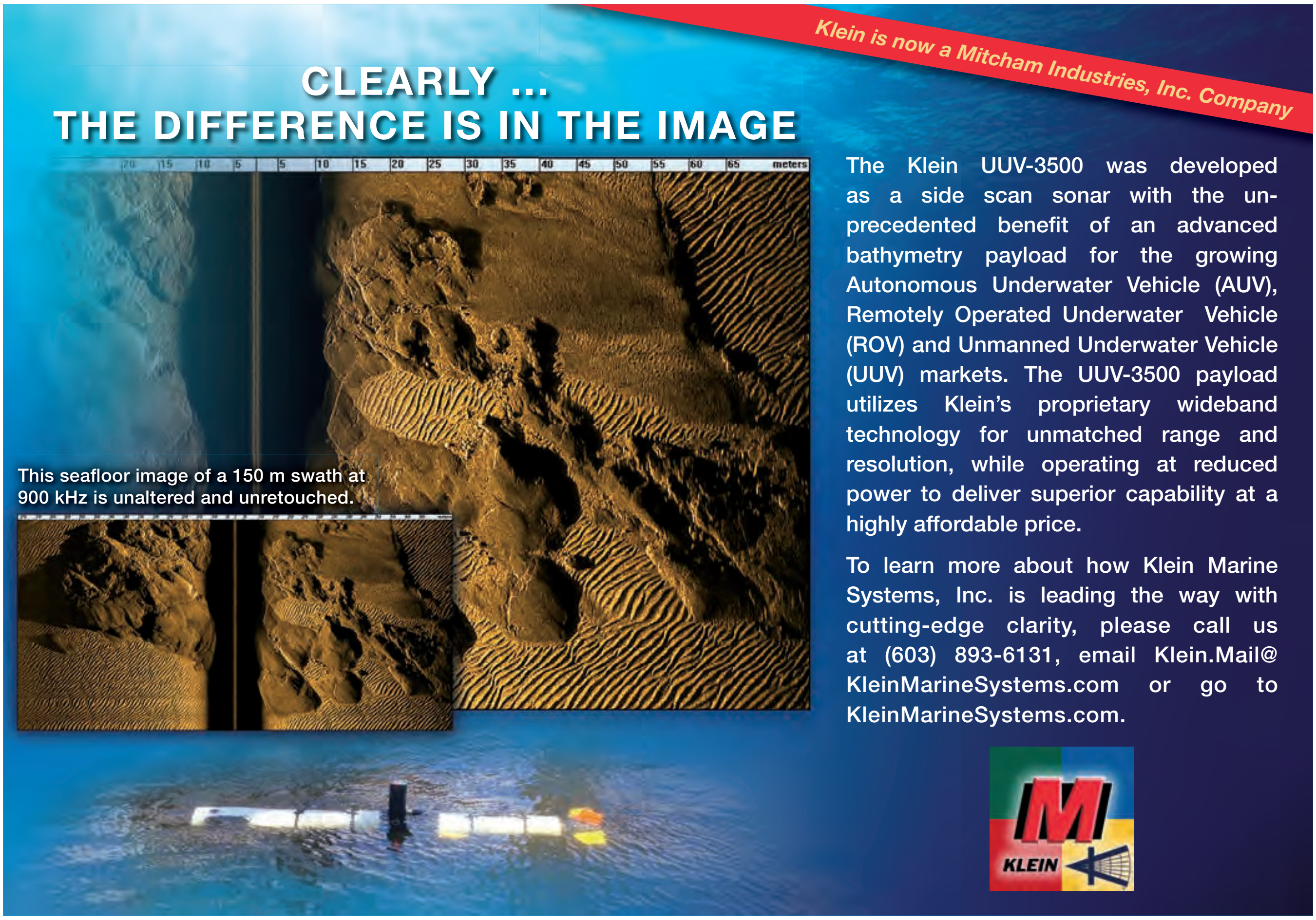
"It is a great project, I really enjoyed working on it. Initially, I was a bit reserved at the prospect of developing a mission scenario for a space mission maybe 30-40 years in the future as it sounded a bit far-fetched. Seeing our results after this relatively short time in comparison, I am more confident than ever that such a mission might be possible in the future. And it definitely is a plus that one day I might be able to tell my kids 'I was part of the project that paved the road to finding extraterrestrial life,'" concluded Hildebrandt.

Photo: ISE

Past Milestones, Promising Future

AUVs Under Ice

By Peter King



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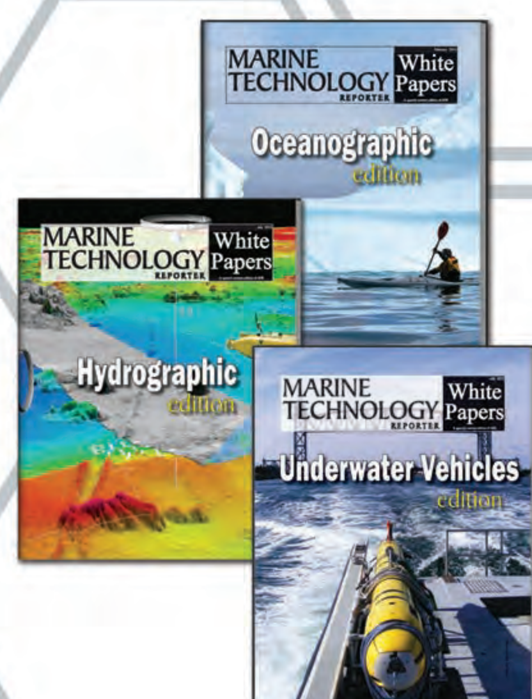

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The marine environments beneath ice are arguably some of the least accessible on earth. Ice is a formidable physical barrier that can range in thickness from centimeters to hundreds of meters—an impediment that has not diminished our desire to uncover the secrets that lie beneath.

In the heyday of manned submarines, under-ice was seen as an important operating theater, where the ability to listen and monitor one's foes was crucial. As manned submarines have given way to unmanned vehicles, the duties of under-ice research have widened to include more fundamental motivations, as we discover more about how ice affects our climate and ocean levels—and seek to understand how these are changing.

Reviewing the major milestones in the use of autonomous underwater vehicles (AUVs) under-ice brings to life how and why the vehicles have developed and helps us make predictions about the form and capabilities of the AUVs of the future.

The Pioneers

It all began in Spring 1972, when the University of Washington's Applied Physics Laboratory (APL) deployed its Unmanned Arctic Submersible (UARS) beneath Fletcher's Ice Island, an iceberg near the North Pole.

This untethered robot, a direct descendant of the very first AUV, was deployed through a hole cut into the ice and conducted a series of out-and-back transects, collecting data related to the acoustic reflection coefficients from the underside of ice and the topography of the base surface.

The UARS was equipped with an acoustic pinger, monitored by two ice mounted hydrophones. As the UARS performed its transects, the received signal – both direct and reflected – provided characterization of the acoustic environment and the reflectivity of the ice over a range of grazing angles. In addition, the signal was received by four tracking hydrophones that provided the position of the vehicle over an area of 0.8km squared. The UARS also carried a three-beam, upward-looking sonar that collected ice draft data.

For AUV operators, a true mark of success is retrieval of the vehicle and data at the end of the mission. For UARS, this was an especially challenging task as the only route to the surface was through the small launch hole. To return a 10-ft. long vehicle with minimal onboard navigation and that has just conducted 17.5 miles of transect, a homing system was developed prior to deployment. This consisted of a single acoustic beacon suspended through the recovery hole.

On board the UARS were two forward-facing directional hydrophones and an aft mounted, omni-directional hydrophone. The received signal from the beacon triggered the UARS to return home and steer on target. Using time-of-arrival differences, the UARS could distinguish the bearing to the beacon and understand whether it was facing towards or away from it. Upon arrival at the site, a barbed probe on the nose of UARS entangled with a suspended

An Ice Hole for deploying an AUV in this climate.

Photo: Australian Maritime College

Photo: Damien Guihen

recovery net, allowing recovery by the gantry.

And Then there was Theseus

As new technologies emerge, there will inevitably be leaps taken to push the envelope of what is possible. For under-ice AUVs one such leap was Theseus. Developed by International Submarine Engineering (ISE), Theseus was a 10.8m, 8,600kg giant, designed to lay up to 220km of fiber optic cable in ice-covered waters.

Theseus implemented a layered and modifiable software architecture for real-time control. This system relied on a fault detection and response system to handle error events though the various stages of a mission. To handle the navigational requirements of such long distance transects, a ring-laser-gyro system coupled to a doppler velocity log – measuring relative speed – was employed to deliver positional accuracies of better than 1% of distance travelled. An external acoustic system was used for cable delivery and vehicle recovery.

In April 1996, following initial endurance testing and trial, Theseus completed a one-way transect of 175km in the ice-covered waters north of Canadian Forces Station Alert. Launching consisted of a gantry launch through a 2m x 13m ice hole. The mission had a series of six acoustic beacons along the path to aid in directional homing, with the first two monitored for telemetry contact. At the mission terminus, Theseus was required to fly through a 200m wide metal loop to capture the cable; as it approached, manual control was enacted to fly the vehicle through the goal.

At this point, Theseus parked under the ice and awaited instruction. Following cable recovery, a position update was provided and the journey home began. Near the end of the return trip, a failure to home on one of the beacons enacted the fault control and Theseus again parked under the ice. Using telemetry, final instruction was given to return to the launch hole. Following this record-setting run of 350km, Theseus completed a follow up mission of 320km.

The AUTOSUB story

Following successful missions beneath sea-ice in the North Weddel sea in 2001 to survey Antarctic Krill, an ambitious five-year program was initiated to investigate the marine environment beneath floating ice shelves. The Autosub Under Ice (AUI) program of the U.K.'s Natural Environment Research Council (NERC) would investigate both the Arctic and Antarctic using the Austosub-2 AUV, designed and built at the U.K.'s National Oceanographic Center, Southampton. This 7m long, high-endurance AUV included an advanced positioning system which consisted of a fiber-optic gyro and both upward and downward Doppler velocity logs (DVLs) for bottom, under-ice, or water column speed tracking. The Autosub-2 had a obstacle avoidance scheme that could allow it to venture into unknown environments.

From 2003 to 2005 the Austosub2 performed under-ice missions in both

Theseus from International Submarine Engineering (ISE)

Photo: Damien Guihen

the Antarctic and Arctic, where a number of major feats were accomplished including the first multibeam image of the underside of sea-ice, taken off northeast Greenland. A major milestone was reached in 2005 when the Austosub2 ventured 25km beneath the Fimbul Ice Shelf; an amazing first for an AUV. This mission allowed retrieval of data in an environment virtually unreachable by previous means and yielded the first ever image of the shape of the underside of an ice shelf, showing a much richer topography that previously thought.

The Austosub program showed what was capable with an AUV operating under ice, but also highlighted the real risks involved: on a follow up mission beneath the Fimbul Ice Shelf in Antarctica, the Autosub's emergency beacon was heard, indicating an abort. At a location about 14kms from the edge, the Autosub-2 was lost.

Following the loss, two outcomes emerged. The first was a realization that the risks of AUVs operating under ice need to be better understood. As a result, a body of work began to emerge from Southampton involving much of the wider AUV community to try and model the failures of AUVs. The objective was to help predict, or at least quantify, the potential risk of loss and has benefited today's under-ice operations. The second outcome was the development of Autosub-3, a new vehicle that would go on to successfully survey beneath the Pine Island Glacier in Antarctica in 2009.

A Record is Born

In 2010 International Submarine Engineering (ISE) once again raised the bar for distance and endurance in under-ice operations. This time, their Explorer AUV, a 7.4m long, 5,000m depth-rated vehicle, would be tasked with measuring the topography of Canada's Northern continental shelf.

Submerged for 12 days, the Explorer would conduct three missions: a 320km transect departing a near shore ice camp to a remote camp located on an ice floe; a 280km mission out from and back to the remote camp; and a 320km return trip. During these missions the AUV would not be recovered, but would instead dock at a through-ice capture system developed and tested the previous year by Memorial University of Newfoundland. This system would allow the AUV to be held fast, charged and provided with a wired connection for data exchange. It also supplied a means to realign the internal navigation system. To reach a remote point after such a long journey, a novel homing system was developed to allow the AUV to steer toward a single, low frequency sound source.

What's next?

For those of us who hope to stand on the shoulders of the aforementioned giants, what will the next generation of under-ice AUVs look like?

No doubt they will be more efficient, with new power sources, enabling endurances beyond the hundreds of kilometers into the thousands of kilometers. They will be more aware of their surroundings, relying less on pre-scribed mission scripts and more on general guidelines where the missions can adapt to what is sensed.

Improvements will be seen in how they navigate and position themselves, relying more on perspective observations of the environment and self-generated maps.

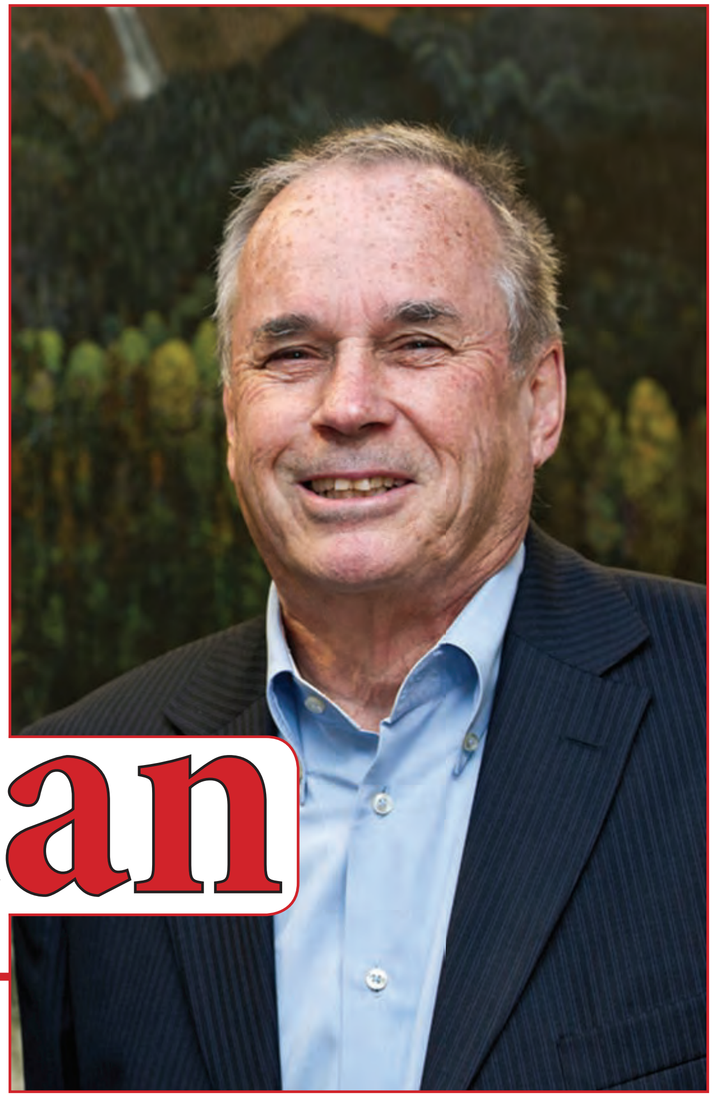
We will see developments into physical interaction, adding to the existing remote sensing capabilities, where physical samples may be taken from these remote areas.

Under-ice AUVs will become more common, and with that, more reliable to the point where their use will be ubiquitous in the collection of critical data locked away below the ice.

We will even see them used in the ice-covered oceans of other worlds, such as Jupiter's moon Europa. (see related story on page 22, this edition).

AMC is establishing an AUV research facility to house a fleet of AUVs, include a new Explorer class AUV from International Submarine Engineering (ISE) for under-ice exploration in Polar Regions.

Designing for Ice with Ian Jordaan



(Credit: James Delgado Collection)

By Andrew Safer

Dr. Ian Jordaan, Professor Emeritus and University Research Professor in the Faculty of Engineering and Applied Science at Memorial University, and President of Ian Jordaan Associates, Inc.

How did a South African engineering student end up in Newfoundland?

I immigrated during the time that Mandela was imprisoned on Robben Island. I was strongly pro-Mandela. I went to England first, where I did doctoral studies, and then I immigrated to Canada and obtained a position at the University of Calgary. Then I entered consulting work with Det Norske Veritas in Calgary. They had formed a Cold Climate Technology Center.

I became head of research and development for them and later became vice president in Canada for R&D. In the early 1980s when I was at DNV, Calgary was the chief place for the Arctic because access was generally from Calgary north. Quite a few oil companies were there. It was a logical place for DNV to do cold climate technology. The idea was to tap into Canadian expertise. In 1986, I was fortunate to obtain a position at Memorial University (in St. John's, Newfoundland) as a research chair, sponsored by Mobil. The focus was to investigate ice-structure interaction, which I had been very interested in when I was working for DNV. This gave me a chance to do research in more depth.

The position here at Memorial was the NSERC Mobil Industrial Research Chair in Ocean Engineering. It was the first Collaborative Industrial Research Chair established at Memorial, and among the first in Canada. Fairly soon after coming here in 1986 I started working on several projects with C-CORE. I've worked on and off with them ever since, usually on a project basis. I have worked on various aspects of Hibernia, Terra Nova, White Rose, Hebron and other projects offshore Newfoundland and Labrador. I've also worked on projects in the Beaufort Sea, Barents Sea and Caspian Sea.

What are the biggest challenges in providing engineering solutions for industries that are operating in ice-prone waters?

The biggest challenges are to get a handle on (1) how to set design criteria, and (2) how to understand ice loads. (1) For design criteria, the focus is very strongly on using risk-based methods, probabilistic methods. One could very easily over- or underestimate what a safe design is. There is a reasonable point where the structure is safe enough; it's not unsafe, and it's not overdesigned. If you design for the biggest feature ever seen, like the 13-kilometer ice island seen off St. John's in the 1880s, you'd be designing for something that is quite unrealistic. So, the idea is not to overdesign. We decided to use a risk-based method: to minimize risk to human life and the environment without necessarily having to design for the worst feature ever seen. We set risk criteria that follow civilized norms, and worked out what the corresponding ice feature would be.

(2) Regarding loads, I've spent a lot of time on the mechanics of ice interacting with structures. For example, with a circular structure, many features may hit on the side in glancing blows. You consider the shape of the ice feature, say, an iceberg, and the speed it's travelling. To arrive at the number of ice features per unit area, looking at data from the International Ice Patrol is a good start for the Grand Banks. All of the data figures into the calculation. Now you've got the risk down to a very acceptable level. You didn't go for excessive overdesign. I believe that this approach helped a lot with making things happen here. Having this industry here, from my point of view, has been a healthy development for Newfoundland and Labrador.

The other part (of ice-structure interaction) is how ice fails. It's very tricky and quite complicated. When I held the Chair here, we had some field programs using a medium-scale indentor. Mobil had used this device to measure forces in a tunnel inside an iceberg. We installed it inside a trench to push against the ice feature from either side and measure the forces and pressures. Mobil Oil Canada Properties donated the indentor and associated equipment to Memorial. With the help of Sandwell (now Ausenco), one of our experiments was to fill up compressors with compressed air, release it all in just a few seconds, and measure the impact forces and pressure distribution. This was done on an ice island in the Arctic that had been used for a variety of experiments including seismic readings. We dug a trench in the ice and used the indentor to measure the forces and pressures. When the indentor pushed against the ice, we saw finely pulverized crushed ice coming out. Pushing into it, applying pressure and shear was producing microstructural changes resulting in tiny grains of ice. Parenthetically, when continents push together, the same thing happens in mylonites (rocks), which have broken down into finer grains.

Ice is one of the few materials that exhibits pressure melting. When there is enough pressure on it, it starts to melt, and the melting point decreases under pressure. That's unusual. Pressure softens the ice, and when it's ejected, it comes out as a finely grained powder. Pressure melting is related to the fact that ice expands on freezing.

There are also significant challenges because we're working with ice mechanics. This table here has nice, defined geometry. It's level; you can put a load on it and work out the stresses, and compare it to failing stress. You don't necessarily have to worry about the details of how it cracks up. If you have an ice feature, there's irregular geometry, and the feature is not going to stop when our mechanics assumption suits us. There's crushing, recrystallization, and other things that are very much at the leading edge of what we can do. We're going into an area where there are great difficulties in treating the mechanics.

The fracture problem is the worst part. It's very random. Floes can split; features can break in half, bits can peel off; there can be local fractures associated with high-pressure zones; there can be large fractures. Fracture happens where there is a flaw in the ice. Grain boundaries are a significant source of crack propagation. Large features can break off in ice; icebergs calve. It's very hard to estimate what is going to happen.

The mechanics are complicated partly because ice has a high homologous temperature (close to the melting point), so it's prone to change its structure. The recrystallization is quite dramatic. Locally, it can be 1 million times softer than the ice next door. Classical mechanics does not work except in some domains. When you have break up, you get crushed ice and high-pressure zones; you can't use plasticity or elasticity. Also, ice changes with time. If stressed, it will change its structure and its response. You can't treat it as a time-constant substance.

Why is it important for designers to know about the mechanics of high-pressure zones in ice-structure interactions?

When it comes to high-pressure zones, the Titanic is a case in point. One view, mistaken in my opinion, was that the riveters were at fault. If we have a vessel that is not ice-class, we don't go into areas where there are icebergs and expect the berg to get out of the way. I think the riveters did a fantastic job, heating the rivet, throwing it up, and popping it in. That ship was designed for the North Atlantic in terms of waves, but certainly not for impacts with icebergs. I think high-pressure zones factored into the disaster. We did some calculations on the plates, and then worked out the force on a rivet. It seemed to be more than enough to pop a rivet. It's like a can opening. You pop one and the fracture extends, and it gets easier from there. You can't say she's "invincible" to loads for which she was not designed.

High-pressure zones and pressure melting are also

CCGS Amundsen breaking multi-year ice in Baffin Bay.

(Photo: Canadian Coast Guard)

the seat of ice-induced vibration.

In the Molikpaq structure in the Beaufort Sea (right) in 1986 there were severe ice-induced vibrations. Ice was pushing in, the structure started vibrating, and crushed ice was ejected, forming piles that were meters high. There is very high pressure associated with the crushing process. When the ice recrystallizes, it softens under pressure, and behaves like quite a different material.

We believe that vibrations occur because of pressure melting: a change in pressure within the high-pressure zone. When the zone fails, the load drops and the melting reverses, and then the load increases again, resulting in an alternating load. There can be synchronization between different high-pressure zones interacting with the structure.

It's important to design the structure for both global loads and local loads. When ice is confined and is not subject to cracking, high-pressure zones form, up to 70 megapascals locally on very small areas. They cause problems for local design. There is very high local punch, like there was with

(Photo: Gulf Canada Corp.)

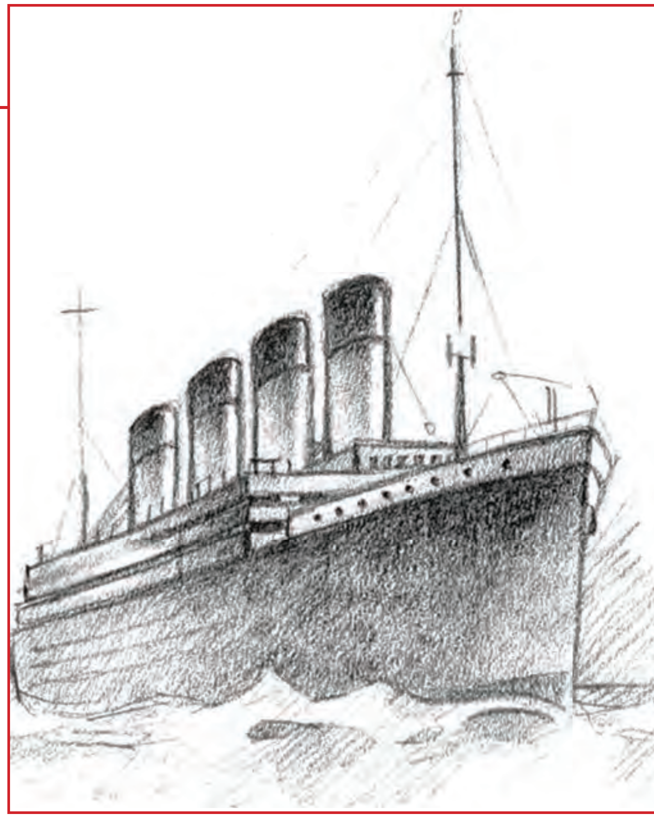
The Molikpaq, a mobile Arctic oil drilling caisson platform designed for operation in the Beaufort Sea

the Titanic. You can get a zone that is relatively fracture free, resulting in a significant high-pressure zone. It can tear the plate apart, like with the Titanic. If you have a vessel carrying oil, there might be a significant environmental consequence if the plate tears.

Floaters have double hulls, which adds to safety. Even though we use welded joints, it could still tear the plates and the welds, if not designed for the appropriate local pressure. Access to full-scale data helps a lot. There have been a lot of expeditions up north with instrumented ships. There was one this last summer. In the past, in planned experiments, strain gauges were placed inside the hull. They might ram that vessel into the ice, during which they measure the pressure distribution. Based on this data, we can develop criteria for various ice scenarios. If I'm working on a design, there is nothing better than full-scale data.

At the Arctic Technology Conference here in St. John's in October, I am presenting a paper, "Estimation of Ice Loads Using Mechanics of Ice Failure in Compression", which focuses on high-pressure zones and the use of mechanics for design. It highlights the necessity of using full-scale data, and also how mechanics can supplement that considerably.

Titanic



(Credit: Illustration by Grant Boland)

How has the melting of the Greenland ice sheet been impacting oil and gas operations?

It has resulted, I believe, in possibly increased release of icebergs and ice islands. I understand that the people who have been working on this have deduced that the ice islands have come from Petermann Glacier. I worked intensely on the problem of designing for icebergs and we built software here, using the Monte Carlo method, doing repeated simulations of icebergs and structures, which allows for solving complex problems without trying to solve by using a single equation.

How is climate change taken into consideration when designing an offshore structure in an area that is currently ice- and iceberg-prone?

I am certainly not a climate denier. Glaciers might calve more often for a while, if the warming trend continues. There might be increased aerial density. For shipping, first-year ice is a big hazard in the Beaufort Sea. It might in some years be clear of ice. But the presence of ice has always been very variable. There is tremendous variability.

If you go into areas where multi-year ice is present, there are places where the thickness is hardly diminished. If you want to go through the Northwest Passage, in some areas you can do so much more easily, but you still have to go through the channels between the islands to get all the way through, and it can still be very demanding. Multi-year ice in some cases hasn't diminished. We believe the thicker ice is still a big hazard. There is no sign it's totally disappearing. First-year ice may be diminishing, but multi-year, with the brine drained out of it, is harder. A multi-year ridge occurs when first-year sea ice compresses against itself, fractures, and breaks into smaller pieces, or blocks, that stick together. If this jumble of ice remains, it becomes a multi-year ridge. There is a zone in the Beaufort Gyre near the Canadian Archipelago where you get ridges forming. It gets thicker and thicker until it's thick enough to survive next summer. A lot of it gets pushed in between the islands in the Canadian Archipelago. It's quite hard to deal with. Multi-year ice poses the main hazard for shipping in the Arctic.

Aside from the anthropogenic reasons for climate change, there are natural reasons why there is a warming trend. There are cycles related to other factors. Some people are implying that the Arctic is becoming like the Mediterranean, which is totally ridiculous. Ken Croasdale, Bob Frederking, and Peter Noble, co-authors with me of the CAE study "Engineering in Canada's Northern Oceans: Research and Strategies for Development", are vastly knowledgeable about ships in ice. We need to put more money into Arctic research and increase efforts to deal with these problems to inform what we can do in the Canadian Arctic.

In general we design for present conditions and then extrapolate them out over time, and then look at some sensitivities and possible future changes. Often there is more variability than trend. It is difficult, for example, to detect an increase or decrease in aerial density of ice features.

Since the Titanic, the International Ice Patrol has

produced data every year. We've been mapping the months and years for this area based on their data. Some years there are no icebergs at all in a given area, some years there are many. The other hazard is calving. You get small icebergs and bergy bits, accelerated by waves. (A bergy bit is glacier ice, 1 to 5 meters above sea level and 5 to 15 meters long.)

Wave-induced motions increase the kinetic energy in impacts against a floating structure. It's harder to detect icebergs in a high sea state, which is an issue for floating structures. High sea states are associated with wind and rain. Waves can accelerate an ice piece, and there's a decreased chance of detecting it. The joint probability of having a very extreme wave and having an iceberg in there at the same time is very low. Lesser sea states are more common, particularly for floaters. The larger icebergs are generally towed and the floating systems can disconnect and move off location. With fixed structures, you have to worry about bigger bergs. While they are not affected by sea states as much as small ones, they might be the biggest hazard in this case.

Who would you say is the leader internationally in designing for ice?

I'd say C-CORE is the leader. They have a very good

Field team collecting sea ice samples in pack ice in the Arctic Ocean.

(Photo: C-CORE)

understanding of risk-based design and probabilistic methods, put together in very elegant computer programs that can help us design. And they have an appreciation of full-scale data.

The group here has analyzed all kinds of full-scale datasets including both ships and structures in ice. Memorial University is certainly amongst the top few for ice research, particularly in medium-scale testing. There is vast experience from work on ships in ice, such as experiments conducted by people like Claude Daley. We have a lot of experimental work going on, and collaborations with the National Research Council of Canada. Put all those facilities together, and it makes a very strong effort—certainly in the top few.

Part I ROV Technology

Over the years remotely operated vehicles (ROVs) have evolved a great deal. There was a time when it was much easier to lump them into categories or classes, such as observational, inspection and work class. Today, many users of the technology have witnessed a trend toward being able to do more with smaller platforms. Smaller sonars and other tools have allowed end users the ability to work from varied vessels and platforms. The larger vehicles have evolved to go deeper and collect more data than ever before, and hybrids have made an impact on the market. In this issue we look at some of the observational, inspection and heavy work class vehicles making a splash in ocean exploration, oil and gas, construction and homeland security. There is overlap in these groups and not all systems are represented. This is part 1 of a 2 part series, as *MTR* covers Light Observatinal/Inspection Class ROVs in this edition, and Inspection Class & Heavy Class ROVs in the November/December 2016 edition.

By Rhonda Moniz

Observational/Inspection Class

VideoRay

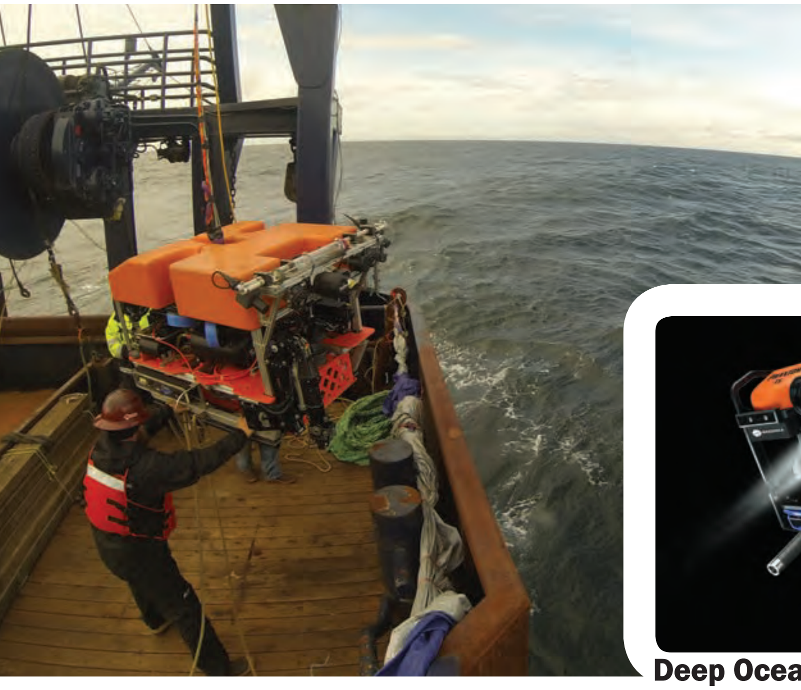
VideoRay LLC

VideoRay was established in 1999, and has worked with technology and mission partners throughout the world to develop the small ROV tool for a wide range of applications. The VideoRay Professional ROV system, gives the user the choice of the multiple options including sonars, positioning systems, metal thickness gauges, cathodic protection, water quality and radiation measuring devices. The systems are used for inspection, scientific research, aqua culture, law enforcement, tunnel inspection and water management. "There have been a number of challenges in the market, but all markets have evolved. It is important to understand that customers are getting better products than say ten years ago, "said Chris Gibson, Vice President of Sales and Marketing. "Years ago the primary focus was just to get video, but as the markets have evolved there is a challenge to get more data in a cost effective manner."

Deep Ocean Engineering

Deep Ocean Engineering started as a small engineering company in 1982 and has more than 600 ROV systems currently being used in the field worldwide. Based in San Jose, Calif., Deep Ocean Engineering accommodates ROV and USV needs encompassing sales, service, production, instruction and installation. "New ownership took over about five years ago. Since then the company has focused on re-establishing it's identity. Our focus now is to make the company an applications focused company. By application based we mean solutions for end users. We are providing custom solutions that meet the specific needs of the client," said, Raúl Peña, VP of Sales and Marketing. "For

DOER ROV



Deep Ocean Engineering

example our ROV's are built by us. We create them to be the best in class. We canthen add a suite of tools based on all of the technologies out there. It is a matter of matching up our capabilities with the needs of the client. Our emphasis is that our vehicles are powerful expandable and rugged."

DOER Marine

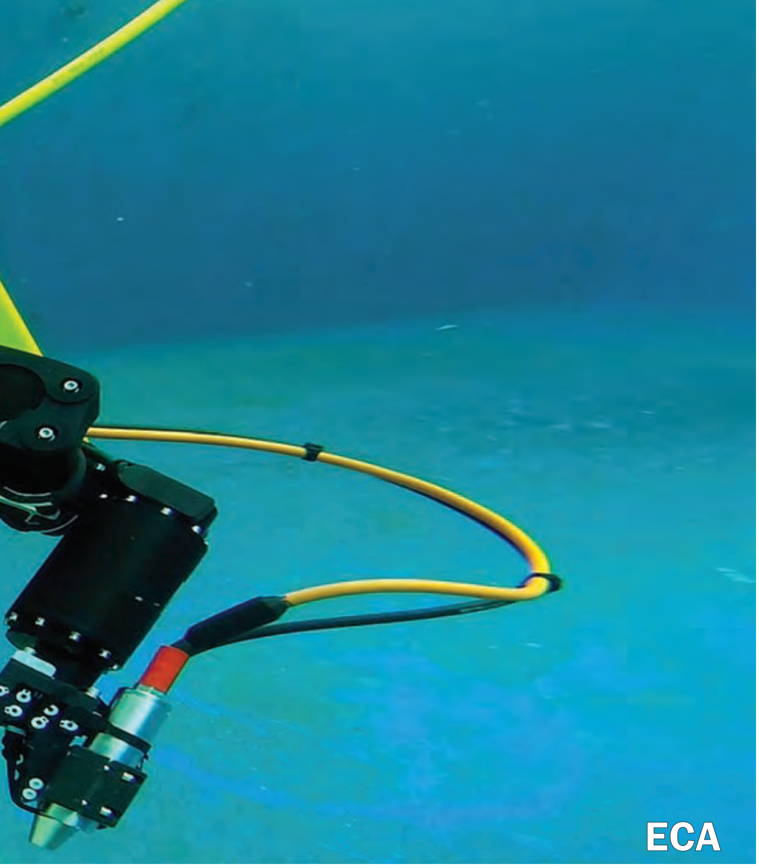
DOER has been designing and building solutions for underwater and harsh environments since 1992. It is a small, woman-owned, family business. DOER has helped clients optimize existing systems as well as undertaking ground up builds. DOER offers compact hydraulic ROVs for depths ranging from near/at surface to 6,500m. All of its ROV systems are "multimission" meaning that they are designed to carry out a variety of tasks and have the ability to be tailored to specific scopes of work. The systems incorporate many materials that can be recycled or repurposed at end of life and all larger systems are designed to fit into standard 20 ft. ISO containers for shipping and/or topside control from vessels of opportunity.

The company offers support services to clients for both manned and unmanned systems. Liz Taylor, DOER Marine's President explains, "The majority of our ROVs are in service to science and film but infrastructure inspection is another area of expertise for DOER. We have built systems to support ocean observatories, to penetrate over 1,000m of ice, to support/rescue manned submersibles, to inspect pipelines over 8 miles long, to carry cinema cameras, to core ice, rock, and compacted sediments, to track, pay out, inspect and retrieve cables, to recover historical artifacts and discrete biological samples and more."

DWTEK Co. Ltd.

As the first marine equipment manufacturer and supplier in Taiwan, DWTEK has devoted its full effort to the enhancement of the subsea industry since 2008. ITs focus on development of ROV and related components includes subsea connectors, propulsion systems, cameras, LED lights and navigation sensors. DWTEK's introductory product, Investigator 90 (I-90) is an observation class ROV. The fundamental design concept behind the I-90 ROV is the creation of an expandable vehicle, which is both functional and versatile.

The expansible capabilities allow operators to follow their expectations, and to customize a full function ROV for specific applications. The highly flexible vehicle design allows the installation of a wide range of different payloads and equipment. "The challenge in this current market is offshore energy which mainly drives the demand of ROVs and creates business opportunities for this industry. The depression of the offshore energy industry market has caused the reduction of new ROV demand," said Lisa Wu. "On the upside it is estimated that the demand for offshore wind power may increase. We will be introducing our new light-work class ROV, Monew. Monew allows operators to equip the ROV with two manipulators for more efficiency and versatility. In addition DWTEK has launched a TMS integrated with the I-90 for a complete solution."



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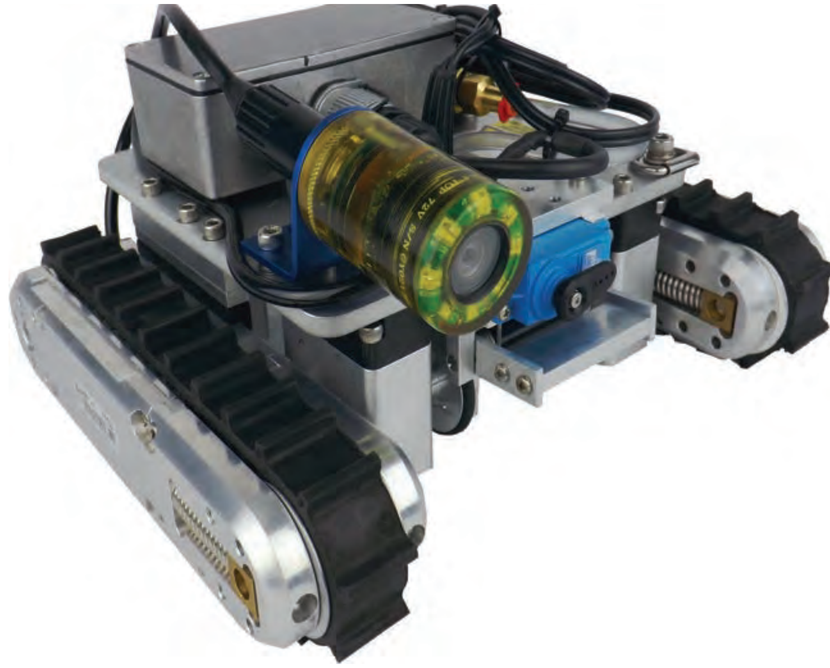


Rovingbat-Hybrid ROV for vertical structures.

ECA

Etudes et Constructions Aeronautiques (ECA) was created in 1936. By 1940 it developed its first maritime project entitled “air torpedo with automatic pilot and remote control.” Fast-forward to present day ECA now offers a wide range of inspection and work class ROV solutions for missions the maritime industry and defense sectors. Their modular ROVs are equipped for multiple applications including subsea inspection, oceanography and environmental monitoring, structure inspection, pipe tracking, black box recovery and harbor protection.

Forum

Forum Energy Technologies (FET) was formed in the summer of 2010 in a five-way merger among Forum Oilfield Technologies, Triton Group, Subsea Services International, Global Flow Technologies and Allied Technology. Since then they have grown through acquisition and organically.

Today it is are a global oilfield products company, serving the subsea, drilling, completion, production and infrastructure sectors of the oil and natural gas industry. Forum products include highly engineered capital equipment as well as products that are consumed in the drilling, well construction, production and transportation of oil and natural gas. Forum is headquartered in Houston, with manufacturing and distribution facilities strategically located around the globe. The Sub Atlantic Mojave is a compact, ergonomically designed lightweight constructed ROV that allows for rapid set up and deployment using any domestic power supply.

Inuktun

Since 1989, Inuktun Services Ltd. has

ISE

JW Fisher

been designing and building remotely operated systems. Its systems are used in hazardous areas, deep water, and in extremely confined spaces. Inuktun's lineup of modular robotic crawlers and cameras make it possible to perform inspection and remote handling jobs safely and efficiently. The Multi-Mission Modular (IM3) technology developed by Inuktun means systems can be quickly adapted for different purposes. Like many companies, "Inuktun has been impacted by low oil prices and tighter spending," said Priscilla Johnson, marketing manager. "Our miniature, magnetic crawler family has rapidly expanded in response to the industry's need for an economical solution for remote visual inspection and ultrasonic testing capabilities in the global marine sector. Assets continue to require attention despite low oil prices. Customers are looking to get the most of their current infrastructure by expanding maintenance efforts rather than replacing or building new."

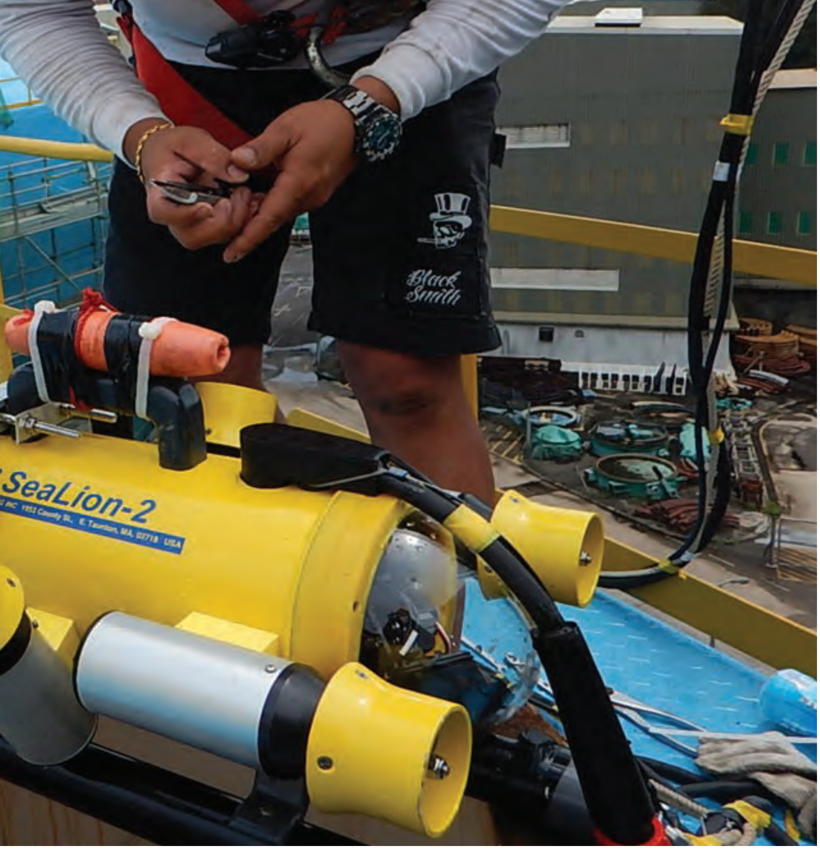
ISE

International Submarine Engineering Ltd. (ISE) was formed in 1974 by Dr. James R. McFarlane to develop, manufacture and sell Remotely Operated Vehicles. At that time the offshore service industry supported subsea oil and gas activities with manned diving spreads and Human Occupied Vehicles. Both of these systems require large support ships for their operation. In the early 1970s, the introduction of high-density electronics and the significant rise in the cost of support ships presented the opportunity to develop, manufacture and market an assortment of smaller, high-endurance robotic vehicles for various subsea tasks. Today ISE's vehicles and equipment are found in all sectors of the subsea marine environment including offshore, cable maintenance, marine science, oceanography and naval mine countermeasures. "One of the important things about ISE is that we are diversified," said Linda Mackay, Manager of Marketing and Communications. "We have different vehicles for different markets. In fact given the current oil and gas market, we have stepped away from dependence on the oil and gas industry and have become more diversified in the sciences. Our vehicles are not off the shelf, but rather built to suit the specific applications for the client."

JW Fisher

JW Fisher, was founded in the mid-60s by Jack Fisher, an avid diver who found himself interested in underwater metal detectors. After designing and making them himself, JW Fishers Mfg. was formed. Mr. Fisher began building and selling his detectors to other divers.

The company expanded its product line and today JW Fisher continues to operate the business and pursue Jack's vision of building a company with the most complete line of underwater search equipment available from any single manufacturer. "Our ROV systems are used worldwide for a number of appli-



Outland Technology

cations including law enforcement, bridge and seawall inspection, and commercial diving, where is proves to be more cost effective and increases the safety factor," said Chris Combs, Sales Manager.

A recent project where the ROV proved essential was the inspection of water storage tank at a local power station. Among the obstacles the dive company had to overcome was devising a way to get men and equipment to the top of the 15-meter high structure, and determining how to get inside the huge tank with an opening only 1/2 meter in diameter. The solution proved to be the ROV which was easily lowered through the small opening, eliminating the need to send a person into the confined space. Operations supervisor Andrew Jenner reported, "The SeaLion worked extremely well sending us back some great video of the tank's interior. It helped make this difficult job so much easier."

Outland Technology

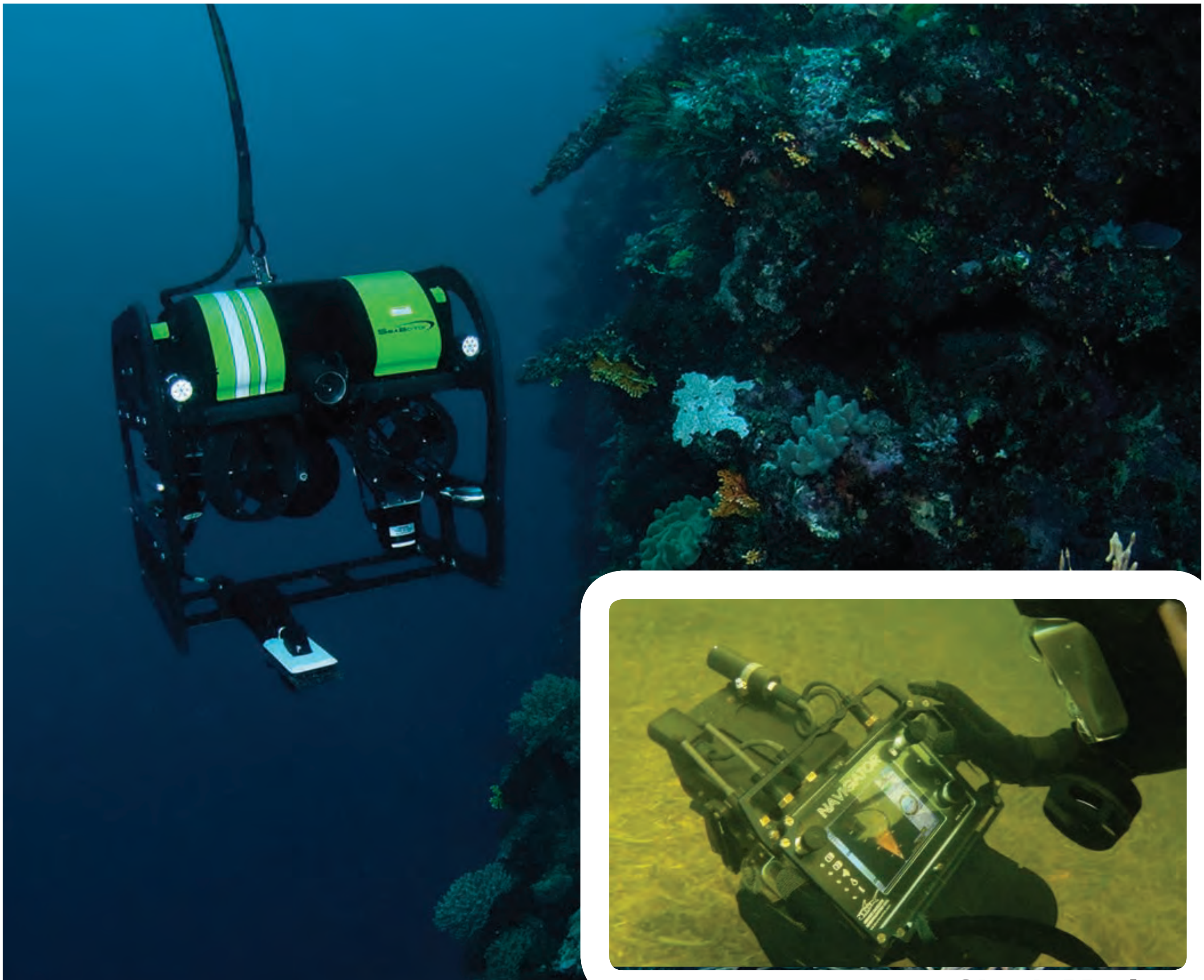
Outland Technology Inc. was established in Gretna, Louisiana in 1984. The company's goal has been to design and manufacture a broad range of high quality video and audio products using high volume components adapted for specific applications. In October 1996, Outland moved into a new 6,000 sq. ft. building in Slidell, La. Since then, it has expanded that building to 13,500 sq. ft. Outland's primary customers are in the Marine, Military and Industrial markets.

"When we started out on the smaller vehicle, which was about 39 pounds, we couldn't get a good cleaner attachment on it, so we went to a little larger vehicle at about 55 pounds. Larger frame, more floatation, bigger motors, much more powerful and we could carry quite a bit of stuff on it" said Buddy Mayfield, of Outland Technology. With the introduction of the Outland 2000, the company also revamped the console for both models and made them modular, meaning one for high voltage (power unit) and one for low voltage (control unit). The models also feature a brand new hand controller and tool controller. The new hand controller includes depth, heading (compass or gyro), cruise controls and an option for altimeter depth control. There is also an option to show CP contact or proximity readings on the screen. Now with LED lights. The ROV utilizes brushless DC, magnetically coupled thrusters. Outland designed a control system around these thrusters to maximize the power. Tilting Camera forward give high resolution and low light color in one small package. A rear fixed camera is standard. The ROV can now use a 1,000 ft. cable.

Saab Seaeye Ltd.

Saab Seaeye Limited is a wholly owned subsidiary of Saab Underwater Systems AB. The company was formed in 1986 by Ian and Janet Blamire to specialize in the manufacture of

Teledyne Seabotix



Shark Marine

electrically powered Remotely Operated Vehicles for the offshore oil and gas industry. Saab Seaeye has recently expanded its production capacity by 50% with the opening of a new 24,000 sq ft factory in Fareham, Hampshire, U.K.

Seatronics

Seatronics, an Acteon company, provides marine electronics to the subsea services market, providing a full service capability, which encompasses rental, sales, personnel, service and repair and asset management. Their market segments include ROV surveys, navigation and positioning, oceanographic systems, video inspection, geophysical surveys, ROV tooling, dving and non-destructive testing and computer systems. Seatronics offers 24/7 technical support throughout their global offices in Aberdeen, Abu Dhabi, Houston, Macaé, Perth and Singapore.

Shark Marine

Shark Marine Technologies Inc. started developing underwater technology in 1984. Shark Marine works closely with other industry leading suppliers to deliver complete integrated solutions. “We are focused on a few different markets with our ROVs. Predominantly we fit that little niche between the larger ROVs and the small ROVs. So our real niche has been the ones that have enough power to do things and yet are still in the light end of it,” said Jim Garrington CEO/President of Shark Marine. Its customer base includes commercial diving, scientific research, survey firms, film production companies, search and recovery organizations and some of the most elite military and law enforcement agencies around the world.

Teledyne Benthos SeaROVER

Teledyne SeaBotix

SeaBotix Inc. was founded in 2001 and over the years a number of cutting edge engineering designs were introduced. There have been numerous applications for the SeaBotix ROV line including offshore oil and gas, inshore coastal surveys, maritime security, scientific research and commercial inspections. The SeaBotix vLBC is a revolutionary approach to ship hull and infrastructure inspections for a wide range of military and commercial applications. With no magnets or thrusters (churning the water, impeding visibility), SeaBotix Crawlers employ the patented Vortex Generator to attach to any relatively flat, hard surface with 22 kgf (48 lbf) of attraction force. With no relative motion between the inspection surface and the sensors, output data is the highest quality possible and operator fatigue is greatly reduced. The patented Crawler Skid is attached to a standard vLBV300 MiniROV in minutes, converting it from a 4-axis ROV to a 5-axis hull and infrastructure crawler. In November of 2014 Teledyne Technologies Incorporated acquired SeaBotix. The company is now known as Teledyne SeaBotix.

Teledyne Benthos

Samuel O. Raymond founded benthos in 1962. Initially the company focused on supplying underwater equipment to the military, government, and scientific community. In the early 1990s market dynamics changed and the company shifted priorities to meet the needs of the growing commercial markets such as the geophysical industry. In 1999 Benthos acquired the products of Datasonics, Inc. a maker of geophysical survey equipment, underwater modems and locator devises. In 2006, Benthos was acquired by Teledyne Technologies Incorporated and is now known as Teledyne Benthos.

The SeaROVER ROV is a compact open frame design. The open frame allows for the ROV to carry sensors in an optimized position for best flight stability. The system includes the SeaROVER ROV, topside control unit, hand box controller and cable, as well as rugged shipping cases.

MARINE
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2017 EDITORI

	FEATURE	MARKET	TECH
JAN/FEB AD CLOSE 1/20	Underwater Vehicle Annual: ROV, AUV, and UUVs	HD Cameras & Sonar for Vehicles	Underwater N
	MTR White Papers: Oceanographic - February 2017 Bonus Electronic Edition Publication Date: February 27, 2017		
MAR AD CLOSE 2/28	Oceanographic Instrumentation: Measurement, Process & Analysis	Fiber Optic Connectors & Slip Rings	Oceanology In Technology Sp
APR AD CLOSE 3/30	Offshore Energy Annual	Subsea Engineering: Subsea Field Architecture	Buoyancy Tec
MAY AD CLOSE 4/28	Underwater Defense	Offshore Renewable Energy: Wind, Wave & Tide	Magnetomete
JUN AD CLOSE 5/25	Hydrographic Survey	Comms, Telemetry & Data Processing	GPS, Gyro Co Motion Tracki
JUL/AUG AD CLOSE 7/28	THE MTR 100 - The 12th Annual Listing of 100 Leading Subsea		
	MTR White Papers: Hydrographic - July 2017 Bonus Electronic Edition Publication Date: July 15, 2017		
SEP AD CLOSE 8/25	Ocean Observation: Gliders, Buoys & Sub-Surface Networks	Research Vessels	Seafloor Engi Operations
OCT AD CLOSE 9/22	AUV Operations	Harsh Environment Systems for Arctic Ops	ROV Technolo Micro System
NOV/DEC AD CLOSE 12/1	Acoustic Doppler Sonar Technologies ADCPs & DVLs	Fresh Water Monitoring & Sensors	Offshore Insp Maintenance
	MTR White Papers: Unmanned Marine and Subsea Vehicles - November 2017 Bo Publication Date: November 7, 2017		

AL CALENDER

HNOLOGY	PRODUCT	SPECIAL	BONUS DISTRIBUTION
avigation	Scientific Deck Machinery	The Atlantic Canada Subsea Cluster	Oceanology Intl North America Feb 14-16 San Diego, CA Underwater Defence & Security March 6-8, 2017, Portsmouth, Uk TUSEXPO Amsterdam, Netherlands
			Delivered to Over 30,000 Recipients Worldwide
nternational 2017 potlight	Sonar Systems & Seafloor Mapping	Southern California Subsea Cluster	Ocean Business Apr 4-6, Southampton,UK Sea-Air-Space Apr 3-5, National Harbor, MD
hnology	Work class ROV's & Seafloor Trenchers	The Norwegian Subsea Cluster	OTC May 2-5, Houston, TX AUVSI XPONENTIAL May 8-11 Dallas, TX USA
rs & Streamers	Subsea Housings	Subsea Mining: The Time is Now	UDT 30 May- 1 Jun, Bremen, Germany MAST Asia Jun 12-14, Tokyo,Japan
mpasses & MEMS ng	Interconnect: Underwater Cables & Connectors		Oceans 2017 Jun 19-22, Aberdeen, Scotland
a Companies			
			Delivered to Over 30,000 Recipients Worldwide
neering & Remote	Geospatial Software Systems for Hydrography	The Northeast U.S. Subsea Cluster	Oceans 2017 Sept. 17-22, Anchorage, AK
gy: Workclass to s	Underwater Tools & Manipulators	The Southeast U.S. Subsea Cluster	OTC Brazil Oct 24-26 Rio De Janeiro,Brazil
ection, & Repair (IMR)	Underwater Imaging: Lights, Cameras & Sonar	The 2018 Subsea Market Planner	Underwater Intervention 2018

onus Electronic Edition

Small Saab Seaeye Couger Conquers Big Task

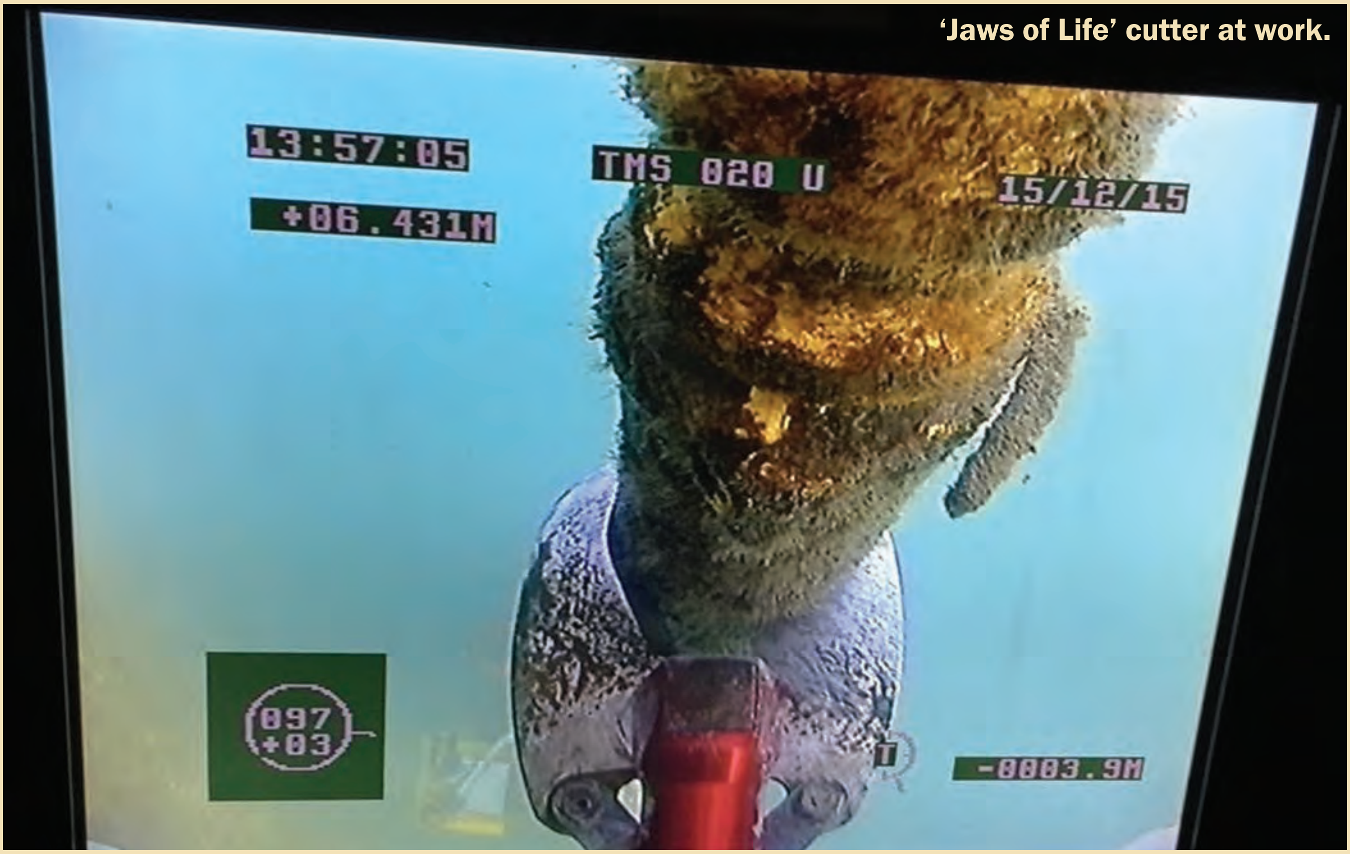
Cutting off 194 grouting hoses from 97 structures in 24 days, DCN Diving deployed a compact version of a Saab Seaeye Cougar XT, measuring just 1.3m x 0.78m, for a work task typically undertaken by much larger systems.

The success of the project came from incorporating a tooling package created by DCN Diving into their Cougar XT Compact, a robotic system specially designed for handling strong currents around wind farms with its six thruster power and low profile structure. Netherlands-based DCN's low cost solution for removing the grouting hoses following installation of transition pieces on top of the mono-piles at the Godewind 1 & 2 Windfarms, came from combining a Seaeye hydraulic power pack with a miniBOOSTER and a TNT Rescue 'Jaws of Life' hydraulic rescue cutter to create a uniquely powerful and effective system. The task for the compact Cougar also included offloading 58 tons of the grouting hose into containers.

The result was a task completed on time, within budget, and to the full satisfaction of the customer, says Fred Bosman, ROV operations manager at DCN Diving who explained the technique used: "We first attached an hydraulic clamp on the upper part of the grouting hose, which was connected to both Cougar and vessel crane. Once the clamp was secured to the grouting hose the ROV was pulled back from the clamp so the hose was no longer connected to the ROV but only to the vessel crane. "Our next step was to cut the hose as close as possible to the lower side of the hose, and the last highest cut just underneath the coupling. At this time the hose was no longer connected to the structure and the vessel crane recovered the hose to the deck where it was stored in an open-top container until off-loaded in port. "Depending on how close we could position the cutter to the couplings, the remaining hose lengths were about 6m long and weighed about 300kg each."

From the start, DCN Diving were confident they could creatively exploit the Cougar's technological architecture and windfarm-relevant design for their needs by harnessing the vehicle's exceptional power, precise control and low-profile design that minimizes the effect of current and a small diameter tether that reduces the effect of drag – all of which enable the Cougar XT Compact to handle strong currents whilst undertaking a wide range of tasks.

www.dcndiving.com
www.seaeye.com



'Jaws of Life' cutter at work.

Photo: Saab Seaeye

BlueROV2: Blue Robotics Launches New ROV

Torrance, Calif. startup Blue Robotics has launched what it is calling the "world's most affordable inspection- and research-class subsea vehicle." The BlueROV2 is a high-performance yet affordable remotely operated vehicle (ROV) that leverages a six-thruster vectored configuration typically only seen in higher-end vehicles, meaning the new ROV is smooth, stable and highly maneuverable, its manufacturer said.

Available in a number of configurations, a standard BlueROV2 kit costs approximately $3,000 and provides a platform to attach scientific equipment, film cinematographic quality shots and explore the oceans down to a depth of 100 meters – with a price tag markedly lower than those of similar vehicles.

"From day one, our goal has been to make marine robotics accessible to more people and businesses than ever before," said the company's founder, Rustom Jehangir.

Since launching its first product, a low-cost underwater thruster motor, through a Kickstarter campaign in 2014, Blue Robotics has gone on to steadily release a line of new marine robotics products ranging from watertight pressure enclosures to depth sensors and underwater lights.

Now, with the BlueROV2 underwater drone, the company has debuted its "new flagship product – a fusion of all of our other products and efforts," according to Jehangir.

"We're able to make the BlueROV2 at a fraction of the cost of similar vehicles thanks to many of the same technologies that have made aerial drones affordable," Jehangir explained. That includes the use of the open-source Pixhawk autopilot as well as a Raspberry Pi computer.

Blue Robotics said that the BlueROV2's low price will enable wider use of subsea vehicles for many people including universities, research organizations, small businesses, hobbyists and first responders. "We know there are a lot of people out there with an urge to explore the ocean," Jehangir said, "and the BlueROV2 is a tool to help them do so."

The BlueROV2 comes as a partially assembled kit that is simple to build and requires several hours of user assembly. It is available for reservation now and will begin shipping out to customers from August 2016.

www.bluerobotics.com

Photo: Saab Seaeye

Allspeed Fiber Rope Cutter

Allspeeds unveiled its largest standard Webtool fiber rope cutter: the Webtool SL165 softline ROV tool, capable of cutting soft and fiber ropes up to 165mm diameter. Deployable either on the manipulator arm of a work class ROV or integrated within a maritime handling system, the cutter operates at any water depth. Made from lightweight aluminum, the Webtool SL165 weighs 49.8Kg in air (33.5Kg in water) and uses 690 bar maximum input pressure. An optional hydraulic intensifier is available. The SL165's corrosion resistant aluminum body and cylinder and long blade and anvil life ensures tool maintenance is kept to a minimum. In addition to the standard tool design, the softline cutter is available in bespoke and custom designs to suit special applications, with the possibility of cutting softlines up to 350mm and more.

www.allspeeds.co.uk

Photo: Allspeeds

Clamp Handling System

Working to a tight deadline, Red Marine delivered a Subsea Clamp Handling System on an eight-week fast-track project for a U.S. based provider of subsea riserless light well intervention services. The equipment was manufactured by Bollinger Shipyards with a Red Marine engineer onsite for engineering support and input. With a working load limit of 15 tons, the system is used to facilitate the installation of a Red Marine supplied umbilical clamp during well intervention operations. Between operations, the handling system can also be used to provide a safe storage and maintenance location for the clamp.

www.redmarine.com

Photo: Red Marine

Image: Fugro

Fugro Q1400 Trenching Systems

Having secured three contracts for its trenching services for oil and gas clients, Fugro has deployed its Q1400 trenching systems in the North Sea: at the Wintershall-owned Maria development in the Norwegian sector of the North Sea under a contract with Subsea 7; at Det norske's Ivar Aasen development for EMAS CHIYODA Subsea; and in the U.K. sector under a contract with Bibby Offshore.

www.fugro.com

2D imaging sonar selected by National University of Singapore's Bumblebee AUV Robotics Team

M900-90 2D Multibeam Imaging Sonar

Photo: BlueView

Teledyne BlueView supported National University of Singapore's (NUS) Bumblebee Autonomous Underwater Vehiclle (BBAUV) team with the M900-90 multibeam imaging sonar. BBAUV designs and builds water based autonomous vehicles for competition and research purposes, and to help bolster student interest in engineering, since its founding in 2012. BBAUV has been taking part in the Singapore Autonomous Underwater Vehicle Challenge (SAUVC) and ONR's International RoboSub Competition held in San Diego, and plans to take part in RobotX this year to be held in Hawaii.

BBAUV managed to clinch second place amongst 40 international teams at RoboSub 2015, in part, due to the P450-E imaging sonar used last year. This year, BBAUV has designed and developed a new vehicle, the Bumblebee 3.0, and one of the main enhancements is the addition of the new M900 imaging sonar. This will double the field of view (FOV) and the range and azimuth resolutions, and its compact form factor will allow the vehicle to be more streamlined.

www.blueview.com

TRIAXYS Wave Buoy Features AIS Aid to Navigation

AXYS Technologies announced the addition of AIS vessel tracking to its signature wave buoy series, TRIAXYS. The SRT Chronos Aid to Navigation (AtoN) AIS is an IALA and IEC compliant device that broadcasts buoy position and weather information to local vessel traffic. This new feature both protects the buoy from collision by notifying vessels of its whereabouts and can also act as an additional telemetry method, providing data within radio range.

www.axystechnologies.com

Photo: AXYS

Photo: Caley Ocean Systems

Linear Cable Engine for Rapid Telecoms Cable Lay

Caley Ocean Systems has developed a high speed linear cable engine (LCE) for telecoms cable laying. Operating at speeds up to 10 knots, the fully containerized Caley LCE can handle cable diameters from 16mm to 50mm and repeaters up to 450mm, and be used on either a standalone basis or in series to handle the extra loads when deploying cable in deepwater. It includes a built-in hydraulic power pack and touch screen controls.

www.caley.co.uk

Image: Kongsbert

SonarWiz Interface for PulSAR Sidescan Sonar

A new tool for real-time seafloor mapping, Chesapeake Technology's SonarWiz mapping software interface allows users of Kongsberg GeoAcoustics' PulSAR sidescan sonar to acquire data from multiple sensors, process imagery in real time, generate state of the art mosaics, create detailed contact reports and produce sophisticated outputs leveraging a wide range of formats. The SonarWiz/PulSAR interface is designed to give users more data manipulation and viewing options, and to allow for easier identification of small targets and change detection through improved across track resolution.

www.chesapeaketech.com
www.km.kongsberg.com

Proserv, KLAW Products Partnership

Proserv has formed a strategic partnership with KLAW Products to offer an enhanced field safety service preventing offshore spills in the Middle East. KLAW Products supplies breakaway couplings and emergency release systems for the safe transfer of hazardous and non-hazardous material. This agreement will see Proserv offering KLAW's products across the region while also delivering in-country technical support.

www.proserv.com

Photo: Proserv

Image: Teledyne Bowtech

Teledyne Bowtech Underwater Camera

Teledyne Bowtech has introduced the updated L3C-HD and the new L3C-HDX underwater cameras to its range of high definition and compact tooling cameras. Both cameras are lightweight and compact, and are suited to tooling, diving and ROV/AUV operations.

www.bowtech.co.uk

New Tech for *Biscay Marine Energy Park*

Cohort plc subsidiary SEA has utilized its power connection technology to install a 13.2kV cable connection in support of the Oceantec wave energy device located at the Biscay Marine Energy Park (Bimep) test site in Northern Spain. A team of engineers and technicians from SEA Subsea Engineering terminated the device cable connection on-shore and travelled offshore to connect the two halves at the wave site. The device is now fully operational and generating wave power back to shore.

www.sea.co.uk

Photo: Cohort PLC

The completed SEA connection fully tested on deck ready for deployment.

Hydroid REMUS Software Updates

Kongsberg Maritime subsidiary Hydroid, Inc. has released version 7.4.0 software updates for its REMUS autonomous underwater vehicle (AUV) and REMUS Vehicle Interface Program (VIP), an intuitive graphical interface that allows users to view the vehicle's status, program missions and download the data, all from one easy-to-use program.

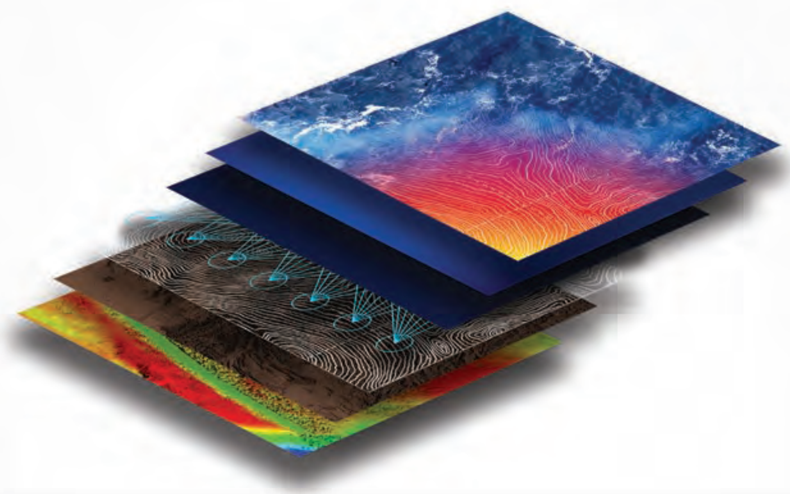
www.hydroid.com

Image: Hydroid

New High Voltage Subsea Power Cable Joint

Power CSL has launched a high voltage jointing system that aims to reduce the cost of repairing subsea cables in the offshore renewables and oil and gas sectors. The joint, unique in its design, is suitable for the offshore repair of a wide range of high voltage subsea cables. It takes 48-60 hours to install, cutting down the waiting time for a suitable weather window and repair vessel time on station. The Power CSL joint, which can be used for repairing subsea cables up to 170kV, has undergone an extensive mechanical, electrical and hyperbaric test program meeting CIGRE 490, 171 and 623 regimes and IEC specifications. The electrical type test was carried out by the KEMA laboratory, with the complete test program being witnessed by DNV GL. The joint uses high tensile strength compression conductor connections. Its insulation system comprises a one-piece cold-shrink molding with internal stress control features, developed by 3M and selected by PCSL for subsea application following close technical collaboration. All moldings are fully electrically tested (HV and PD) during manufacture.

www.powercsl.com



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