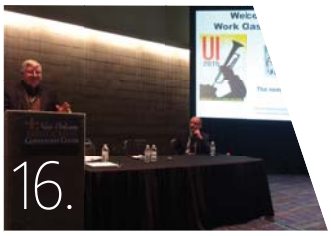
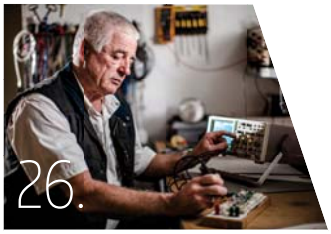
ROV PLANET



Underwater Intervention 2015



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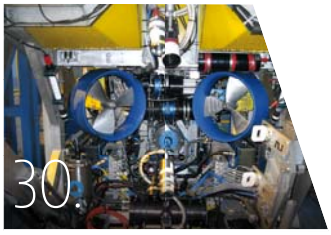

The Science Behind Industry Leading ROV Positioning

Redefining ROV Manipulation

3

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04 / 2015

The magazine of choice for Subsea Construction and ROV Professionals

ABOUT

With 6000 email distributions and 2000 printed copies delivered to the offices of ROV & subsea construction related companies, oil majors and also distributed at trade shows – ROV Planet aims to become the leading publication, online news portal, and forum of the ROV & subsea construction industries.

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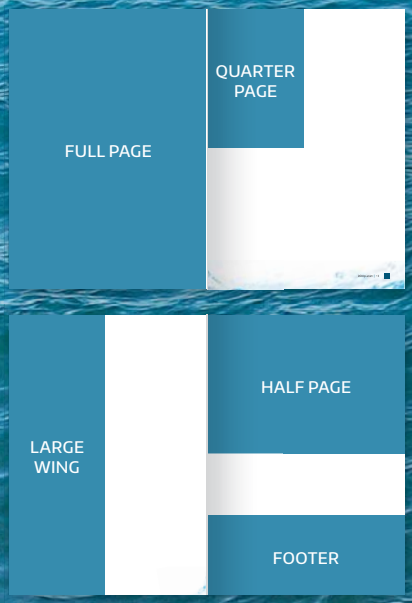

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Front Page Cover Photo and Poster: Courtesy of Forum Energy Technologies

WELCOME TO ROV PLANET

My name is Richie Enzmann and I would like to welcome you all to the new issue of ROV Planet!

We are experiencing strange times to say the least. I would not go into the reasons of the low oil price but I'm sure most people already have their own theories about it. However it's quite shocking how everything has gone to a sudden halt, as if someone has pressed a button to stop a moving conveyor belt. Most major projects are on hold till further notice and no more optimism is in the near future. We can only hope for the best.

This year's Subsea Expo and Underwater Intervention were scheduled exactly on the same days. I was hoping to visit UI this year but ended up staying in Aberdeen for Subsea Expo instead and attended the launch of Forum's new XLX-C work class ROV in the Maritime Museum of Aberdeen. Luckily Steve Barrow was kind enough to give us a detailed coverage of UI, which I found a very entertaining read.

Reaching Ultra has come up with an interesting concept of using robotics in the high pressure testing environment. Opportunities for using Baxter – the friendly robot – are endless and I'm sure we will see more of Baxter in the future in other applications. We will also have a look at how Ron Allum has helped James Cameron to design his Deepsea Challenger to get to the deepest part of the ocean. Finally we are featuring a technical article about ROV positioning with input from the top technical gurus of iXBlue.

Folks, if you have time and would like to give back something to the next generation and your community, then please help MATE with their ROV competition. You can help either as competition judges, supporters, or technical trainers of your local university and high school ROV teams. It's for a good cause. Thanks.

Sit back and enjoy the third issue!

Kind regards,
Richie Enzmann

UPCOMING EVENTS

14-16th April, 2015
Ocean Business – Southampton, UK
The hands-on ocean technology and training forum, and exhibition.

15-16th April, 2015
Offshore Well Intervention Conference – Aberdeen, UK
A conference aimed for maximising North Sea intervention efficiency.

4-7th May, 2015
Offshore Technology Conference (OTC) – Houston, TX, USA
The largest oil and gas sector trade show in the world.

18-21st May, 2015
Oceans'15 MTS/IEEE – Genova, Italy
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25-27th June, 2015
MATE International ROV Competition – St. John's, NL, Canada
A network of 20+ regional contests will feed into the international ROV event.

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Genova_Italy_May 18|21_2015

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The OCEANS'15 MTS/IEEE GENOVA has received a record number of **744 submission**, resulting in **550 technical papers**, accepted after rigorous peer review, to form a **strong and high quality technical program**. In addition, 60 contributions to the Student Poster competition have been selected, with the top ones participating in the final and the others joining the regular conference poster sessions.

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Visit the site: **http://www.oceans15mtsieeegenova.org/** to learn more!
There may be last minute opportunities for exhibit participation and patronage: please contact **operations@totemeventi.it** if you are interested.

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JANE GJESTLAND:

SONG WRITER AND SUBSEA 7 PERSONNEL MANAGER

Jane Gjestland leads a double life. She is a personnel manager at Subsea 7 by day and songwriter by night. Previously Jane has mainly written material for others. However, the new single, 'I Could Get Used to This' is one of the few songs she has written to perform, and the first title that she produced with musical partner Bjorn Erik Sorensen. The pair has teamed up on this track, forming new musical duo, Black Roses.

Courtesy of Jane Gjestland

Both Black Roses and their debut title were created almost as an afterthought. After a songwriting session that didn't go as well as planned, Jane stayed behind in the studio with Bjorn. The pair began throwing around some melodies, and together they wrote 'I Could Get Used to This'. A bout of frustration turned to creativity in the end.

A recording of 15 songs had already been planned with BlackBird Studios in Nashville – owned by Martina McBride and her husband – for another songwriting project, so Jane and Bjorn decided to include their track. Although at the time it still had no bridge and was a completely different style to the other songs, the pair knew it would make a good addition. The evening before the recording, the last part of the song was written in a hotel room and they laid down the completed track the following day. It was a busy day at BlackBird with Kid Rock also recording a song in the other studio and Martine hosting a live radio show with all the press present.

Once the pair returned to their native Norway, vocals were recorded and added at Artbeat Studios. It was clear that the song fitted well with Jane's voice, so the decision was made to keep her vocals, create a band, and release the new single under their name.

Since then, 'I Could Get Used toThis' has garnered a great deal of attention and has received extensive radio play in Norway. The song has been heard and complimented by music industry staff in both Nashville and Los Angeles. It has also been selected for the NSAI's (Nashville Songwriters' Association) 'Pitch to Publisher' (songwriting recognition) and the duo are semi-finalists in the international songwriting competition (ISC). It has even been forwarded to music supervisors for both film and television.

Courtesy of Jane Gjestland

Courtesy of Jane Gjestland

Black Roses are following up on their debut by writing more songs in this genre.
You can download their first track via the link:
http://itunes.apple.com/album/id957014024

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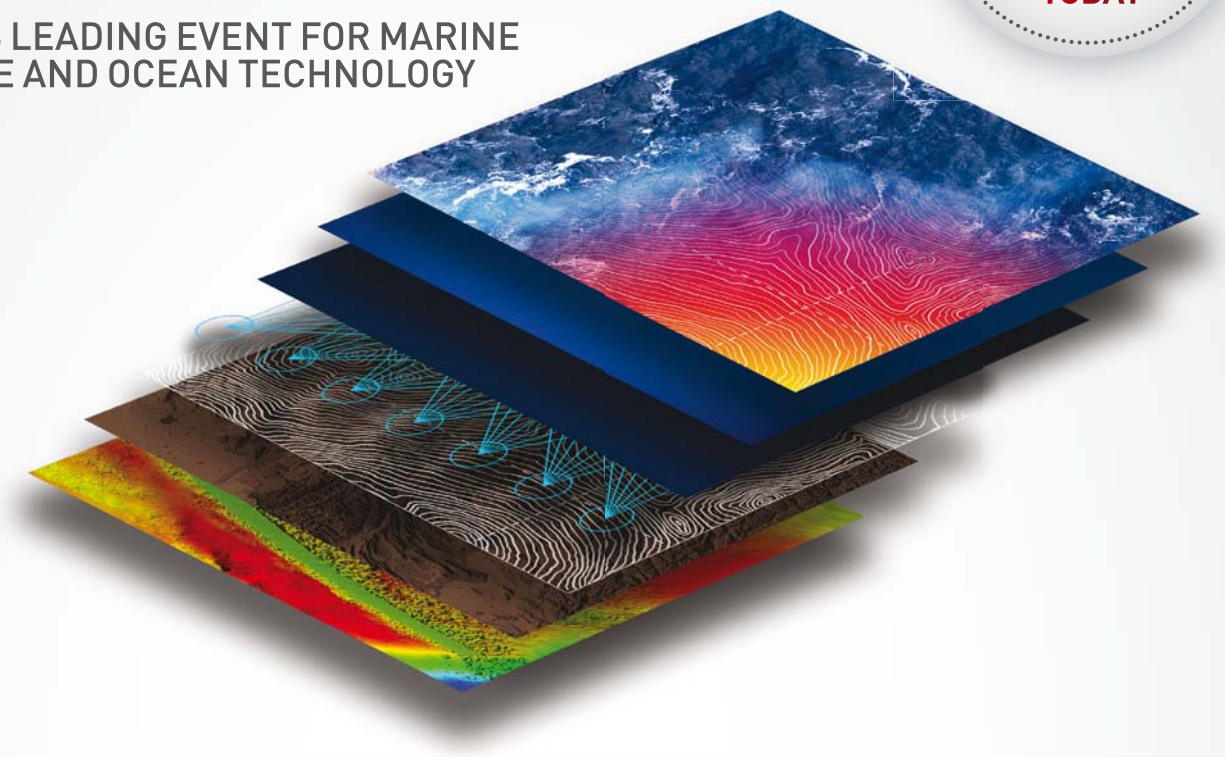

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Courtesy of ToolTec | Nick Wilson, Technical Director and Neil MacDonald, Senior Engineer in the ToolTec offices

THE STORY

In February of this year, at the Subsea Expo's Subsea UK Awards ceremony in Aberdeen, a local start up walked away with the highly coveted 'New Enterprise' award. In a little over 18 months, this new company – ToolTec – has undergone rapid growth to become a key supplier in the ROV Tooling market. ROV Planet spoke to ToolTec founder, Nick Rettie, and his team to find out the story behind their success.

TOOLTEC: THE STORY SO FAR

In April of 2013, standing in an empty rented workshop in Westhill, Nick Rettie had just made a life changing decision.

'In the beginning I was stepping out completely into the unknown.' he explains, recalling the move and his reasons behind it. 'However I was under no doubt that there was a market for the quality services which I was able to offer.' Nick recognized a common problem in the industry, and thought that he could provide a solution.

Guided only by confidence in his own abilities, Nick was about to start a new company: a company which on the day of incorporation was comprised solely of him, his toolbox, and his mobile phone. With no immediate orders for work and no forthcoming start-up assistance in the form of advice or funding, Nick realised that he had a lot to learn very quickly.

The ToolTec story had begun...

Before ToolTec was even a twinkle in his eye, Nick had been an ROV Tooling Workshop Supervisor for a major subsea service company in a career spanning over 15 years. During this time, he held a pivotal role in the organisation. However he felt that his contributions and commitment weren't always acknowledged, and as such he eventually became frustrated with the limitations of his role.

TOOL TEC LTD

Courtesy of ToolTec | Nick Rettie with the New Enterprise Award

It was during this period that Nick noticed a gap in the market. 'Numerous companies were able to offer ROV tooling to ROV operator. However the "bit in the middle" was often overlooked, i.e. the interfacing of the tooling to specific ROV systems.' Nick felt that he had the drive, determination, and professionalism to provide a service capable of fulfilling this niche. 'This is one of the services which I wanted to offer my clients as all too often equipment would get mobilised for projects without any prior interfacing or testing which would result in interfacing problems offshore , delaying project start-up and raising costs.' With this in mind, he took the bold decision to leave his job and begin work on ToolTec.

DAILY CHALLENGES

Word of his service soon spread. Nick's new company offered a service that the market did not have. Furthermore, he already had a reputation within the industry for quality workmanship and attention to detail which had not gone unnoticed; he quickly built a firm and loyal customer base. Commenting on the reasons for ToolTec's rise in popularity, he says 'We are completely independent and not affiliated to any other organization. This leaves us well placed to be able to supply to the "whole of market".

'One of the services which we offer is supplying equipment under license for some of our customers on a fixed price basis.' Within weeks ToolTec had secured a number of contracts

Courtesy of ToolTec | ToolTec Vans parking outside the Workshop


Courtesy of ToolTec


Courtesy of ToolTec | The ToolTec manufactured UHD Skid


Courtesy of ToolTec


Courtesy of ToolTec


Courtesy of ToolTec

which meant that Nick quickly had to become proficient not only in the practical side of the business, but also with the daily challenges which come with any new start-up enterprise.

There were many hurdles to be overcome in the early days. One of the main challenges that Nick had to overcome in the beginning was managing cash flow within the business. He had to balance badly needed income to pay for material and overhead costs against the purchase of new equipment.

However, Nick felt that this was a valuable investment which could further expand the workshop services that he was able to offer. 'ToolTec can provide a "one stop shop" for the complete procurement, assembly, and testing of products both within a timescale and at a price point which is appealing to our customers.', Nick explains. 'We feel that it is unacceptable that some customers are being asked to wait up to 20 weeks for the supply of basic equipment. For example, we are able to supply a multi-purpose underslung tooling skid within only 5 weeks for a fraction of the cost of what others can.'

Following on from numerous successfully completed projects, the company has been able to expand on its products and services. It was even possible to strengthen the workshop's capacity by employing additional experienced technicians to increase capacity in this area. The workshop has now doubled in size, and has additional equipment in place for both product testing and qualification.

As the ToolTec brand gathered pace, various customers began to ask ToolTec to provide bespoke products which involved engineering design elements. Nick seized the opportunity and enlisted the help of a contract design engineer to enable ToolTec to offer this service. 'I was delighted to become a full-time part of the ToolTec team when Nick Rettie approached me last year.' explains Nick Wilson, the new Technical Director who joined the ToolTec team in 2014. 'We are now set-up to offer a professional design and engineering service to our clients to complement the superb workshop services that Nick Rettie and his team have established.

'We set out from the onset to do everything the correct way and to focus on quality of our delivered products and services. Our recent award of the ISO 9001 business management system accreditation strengthens our focus on this important area and gives our customers further assurance that the essential documentation which accompanies projects will be delivered to the highest standards.'

THE ROAD AHEAD

Following on from the Subsea UK award it has been business as usual for ToolTec, albeit with a marked increase in enquiries from both existing and new customers: a direct response to their recent media exposure. As a result, they've made a few changes. ToolTec has since redeveloped the front office to allow further space for more office-based employees. They also recently appointed a Senior Mechanical Engineer with extensive experience of ROV tooling design, and vast operational experience of using such equipment in the field. This appointment further strengthens the engineering capacity of the team with ToolTec now being able to deliver multiple engineering projects simultaneously.

But beyond industry leading expertise and the recognition as an award winning company, ToolTec's success so far seems to be balanced on one simple principle: delivering what their customers want to the highest possible standard. Nick Wilson explains how this rests at the forefront of their business model, saying, 'We are a relatively small but dynamic company looking to supply quality ROV tooling to the marketplace.

'Repeat business through customer satisfaction is the key to our overall success, and with the right team of people in place we can prosper to be a major supplier of ROV tooling at a global level in the coming years. Focusing on our fundamental values of supplying quality and reliable tooling which is not over engineered or overpriced, we believe that our business model is unique in an increasingly challenging business environment.'

ToolTec looks forward to a bright future after a very busy and successful start-up period. With added engineering resources and a continued focus on product quality, onus will now be placed on further development. ToolTec will be bringing new and unique products to the marketplace, and the company is now clearly well placed to build upon its success in the coming years ahead. The rented unit is now an expansive office; the solitary toolbox is now a team of engineers. I'm sure everyone in the industry is excited to see where Nick Rettie and the ToolTec team will go from here.

UNDERWATER INTERVENTION 2015

WORK CLASS ROV TECHNICAL TRACK REPORT

Steve Barrow, WCROV Track Chairman and Sr. Engineer for FMC Technologies-Schilling Robotics | Steve.Barrow@FMCTI.com

This year the Underwater Intervention Conference was held in New Orleans, Louisiana on February 10th – 12th. ROV professionals attended the Work-Class Remotely Operated Vehicle (WCROV) technical tracks to discuss the latest innovations and technology. Although you need to attend the sessions to get all the details, some of the discussion's highlights can be shared in this publication.

DAY 1
TOPICS ON ROV SIMULATION, INTERVENTION, DESIGN AND MANUFACTURING AND USE IN MILITARY APPLICATIONS

Two pioneers of the ROV industry, Drew Michel – former President of MTS – and Didier Renard from Technip kicked off the sessions. These gentlemen have over 90 years of combined ROV and offshore experience. As an introduction to Didier's presentation, Drew told the story of a company that initially saved $100,000 on a project by not performing an ROV task simulation. However, on the very first ROV task, an I-beam was found to be blocking a critical ROV interface. The resulting correction cost $20,000,000. Although the importance of mission simulation is clear, Didier titled his presentation "There Is More to It than Just ROV Access" to emphasize that dimensional clearance checks are not enough to ensure operational excellence. He went on to detail seven important checks that Technip always performs: ROV access, ROV stabilization, ROV manipulation, tooling interfaces, tooling visibility, markings and monitoring, and tether snag points and other traps.

Johnathan Grumbles from Oceaneering shared a summary of the industry's response to the Macondo oil spill, including API Standard 53 that requires closure of blow-out preventer (BOP) rams in 45 seconds or less. He discussed several methods of BOP intervention and described details of accumulator-based systems and ROV skids that have been used to perform BOP testing. He calculates that the worst-case scenario for an ROV to close a BOP within 45 seconds would require more than 300 horsepower. This power requirement poses a considerable challenge for ROV designers and operators.

Courtesy of Steve Barrow: A scene from the French Quarter of New Orleans.

Courtesy of Steve Barrow: Drew Michel (L) introduces Didier Renard (R).

Delta Subsea LLC, Leidos, and Gradient Technology have jointly developed an ROV-powered, water-jet system used in the disarmament and disposal of unexploded ordnance (UXO). Tens of millions of UXOs are currently estimated to exist underwater and require proper disposal. Water jetting is environmentally friendly since it does not detonate the charge (avoiding noise and shock waves that harm marine animals), and a flush and vacuum system collects the hazardous materials to eliminate environmental release. The system has been used to safely disarm hundreds-of-thousands of rounds on the surface, and can even be used to disarm cartridges of unknown design.

Pete LeHardy and Tim Coop from Phoenix International detailed a recent upgrade to the U.S. Navy's Deep Drone ROV. The air-transportable system has for over 30 years supported the highest-profile oceanic disasters and recoveries, including the space shuttle Challenger, the Ehime Maru, and the Macondo oil spill. At the heart of the upgrade, Phoenix installed a completely new Programmable Logic Controller (PLC) based vehicle control system. The new controls system offers increased bandwidth to accommodate advanced sensors and provide intuitive controls, while using commercial off-the-shelf (COTS) components and software that are readily available and supported worldwide. Other systems upgraded on Deep Drone include the topside controls, umbilical, cameras and lights, structural frame, and buoyancy.

Anthony Harwin shared some keen insights on Oceaneering International's decision process on whether to "make" or "buy" certain items. He explained that sometimes it may seem worthwhile to buy an item's vendor, this can have unintended consequences that may even drive up the item's costs. Instead, "reverse integration" can help a vendor provide exactly what the customer wants at an optimized price.

Andrew Resnick, a Senior Engineering Manager for Forum Energy Technologies, pointed out that in the early days of offshore work, a dive was considered a success if an ROV could just get to depth and look around. Now expectations are much higher. Customers assume that an ROV will perform its designated tasks, and the main requirements are safety, reliability, and efficiency. Andrew said that to further advance, the ROV industry must establish metrics to determine where improvements can be made. However, because customers are often reluctant to share operational information or are bound by confidentiality clauses, a method is needed to make the data anonymous and accessible.

Continuing on the subject of efficiency, Matthew Thompson, an Engineering Manager at FMC Technologies-Schilling Robotics, made the case that uptime is not a good metric of efficiency. Too much ambiguity and non-productive time is included in up-time numbers, and no "official" formula exists for fair comparison. Matt used a story about two plumbers, one who transported tools efficiently and one who did not, as an analogy for the transit of ROVs to the surface to change tools. Matt pointed out that these trips impact efficiency and productivity more than most people realize. A recent study found that on a 12-day operation, the equivalent of two full work days was spent doing unproductive activities. If these non-productive hours could be eliminated, the cost savings (for two fewer days of vessel time) would be significant. Matt then showed pictures of manipulators with interchangeable tool end-effectors that Schilling had manufactured in the 1980s. He asked the audience if something like that, with a subsea tool rack of tools, would improve efficiency.

Alessandro Vagata, Vice President of ROV Tooling for Delta Subsea, and Ken Lobo, a Project Manager from Applus RTD, presented a newly developed pipeline survey tool, the Incotest system. Alessandro and Ken explained that more than 400,000 miles of oil and gas pipelines exist in the United States alone, and a NACE study recently concluded that the corrosion-related-cost to the transmission pipeline industry is between $5-8 billion dollars annually. The RTD Incotest system is a non-contact, Non-Destructive Evaluation (NDE) and inspection system that uses pulsed eddy currents to measure average pipeline wall thickness.

DAY 2
TOPICS ON ROV PIPELINE INSPECTION, COMPONENTS & EQUIPMENT, NAVIGATION AND CONTROL AND SUBSEA HYDRAULICS

The second day of the conference began with Scott Dingman, President and CEO of Delta Subsea, moderating the sessions. He introduced John Charlambides and Moe Salhi, from Oceaneering's Pipeline Repair Systems group, who described Oceaneering's various types of pipeline repairs and the equipment used. While minor repairs can be fixed with band clamp, major repairs require the replacement of section of pipeline, no matter the length. John and Moe explained the differences between structural and nonstructural clamps, and they explained the use of weld seam removal tools, pipe lift frames, and specialized equipment to remove concrete and fusion-bonded epoxy (FBE). I learned that the end prep tools are used not only to protect the seals from sharp ends on the pipe, but also to prevent burrs from interfering with pigging operations after the repair. All of the repair equipment is recovered at the end of the mission, with only the repaired pipeline and clamp remaining subsea.

ROV launch and recovery systems must take many different forms to accommodate vessel layout and to meet performance and budget requirements. In addition, the wide variety of optional equipment and certifications can be very difficult to understand. That's according to Jesper Bitsch Kristensen, Sales and Business Development Manager for Sepro Technology. He explained the different types of over-boarding systems. He also detailed the performance of hydraulic versus electric winches, the advantages and disadvantages of right-angle level winds, and the use and requirement for third party certifications.

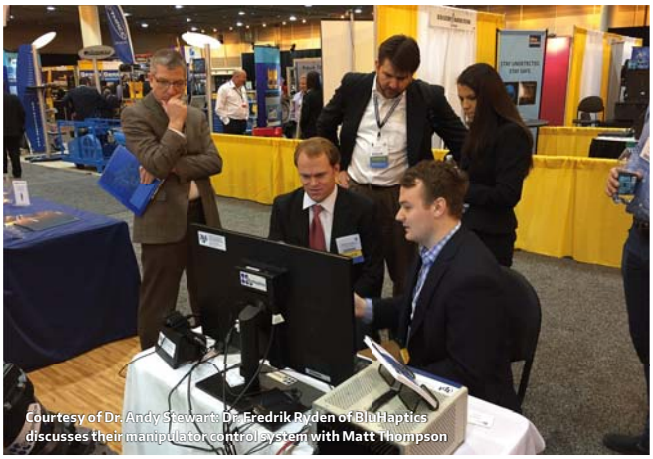
Even in New Orleans, we were not immune to effects of this year's winter storms. Bob Kelly of Trelleborg Offshore couldn't leave Boston due to heavy snow, hence his colleague Ruth Clay gave the presentation in his place. In the early days of deep ocean exploration, the state of the art for subsea buoyancy consisted of gasoline-filled chambers that were counterweighted with iron pellets. Thank goodness syntactic foam has replaced that QHSE nightmare. Ruth explained that syntactic foam consists of microballoons encased in a resin body. The ratio of resin to microballoons is determined by the depth rating required. She discussed different types of available syntactic foam, construction methods, quality assurance and testing methods, and certification. She also discussed failure modes, alerting operators about what to watch for on their systems.

Leon Adams and David White from Southwest Electric (SWE) delivered their presentation on subsea lithium-ion batteries developed for Woods Hole Oceanographic Institute's (WHOI) new ROV Nereid. Nereid is a hybrid ROV/AUV specifically designed for under-ice exploration. A conventional ROV's excursion distance is limited to the tether length, but Nereid uses battery modules to eliminate the ROV's dependency on vessel power, and can operate to an astounding range of 20 km. WHOI placed strict requirements on the size, weight, and power requirements for the battery modules, and SWE's design improved upon most of the requirements. Their modular battery design offers 6-km depth rating, high configuration flexibility, and an emphasis on safety and reliability. The battery-monitoring software monitors voltage and temperature, while offering autonomous control of the charge level within each battery module. The software even isolates poorly performing cells and balances module discharge and recharge.

Continuing on the theme of smart designs, Pete Herder from Hydra Power Systems described design considerations for subsea hydraulic manifolds. There are many good reasons to use manifolds in hydraulic design: decreasing the number of fittings reduces circuit complexity, potential leak paths, weight, and costs. He advised the audience to always begin with a circuit schematic, and carefully analyze all possible flows and pressures in the circuit. Then you can consider how to optimize the circuit. Subsea hydraulics adds a new level of complexity due to corrosion, so Pete reviewed the advantages of various materials and coatings. He described how custom manifolds and valve blocks must be fabricated with particular attention to concentricity and surface finish, two items often neglected by machine shops that do not specialize in hydraulic design. Specialty shops can also help with post-manufacturing items like cleaning and testing.

Mark Miller is the self-professed "Bio Oil Guy", but he is also the Executive Vice President at RSC Bio Solutions. Mark informed the audience about the impact of the new EPA General Vessel Permit (GVP), which affects all U.S. vessels that are greater than 79 feet or operating within a 3-mile range offshore (Permit Waters). This regulation requires that all submersible and high-risk deck equipment use environmentally acceptable lubricants (EALs). These EALs must qualify as being "readily biodegradable" rather than meeting the less stringent classification of "inherently biodegradable." Mark also advised the audience that of the four major kinds of EALs, the polyalphaolefin (PAO) class performs best in the maritime industry. Although the EALs cost 50-100% more than standard hydraulic oil, companies have found the overall cost to be less due to reduced repairs and downtime.

Ben Kinnaman, President and CEO of GreenSea Systems, presented a system that allows ROVs to use sonar for feature-based vehicle positioning. Almost every WCROV has sonar, so this system would use existing hardware to provide additional functionality. Using sonar would eliminate the large and expensive inertial navigation sensors (INS) used by similar systems, and Ben believes that these



Courtesy of Dr. Andy Stewart: Dr. Fredrik Ryden of BluHaptics discusses their manipulator control system with Matt Thompson

Courtesy of Dr. Andy Stewart, Principal Ocean Engineer: Dr. Fredrik Ryden of BluHaptics discusses their manipulator control system with Steve Barrow. [Photos by Dr. Andy Stewart]

sensors are overkill for applications that require only local navigation. Informal field testing has been performed by having an ROV follow a swimmer or another ROV, and the results are promising. GreenSea plans to offer the system as a stand-alone software package.

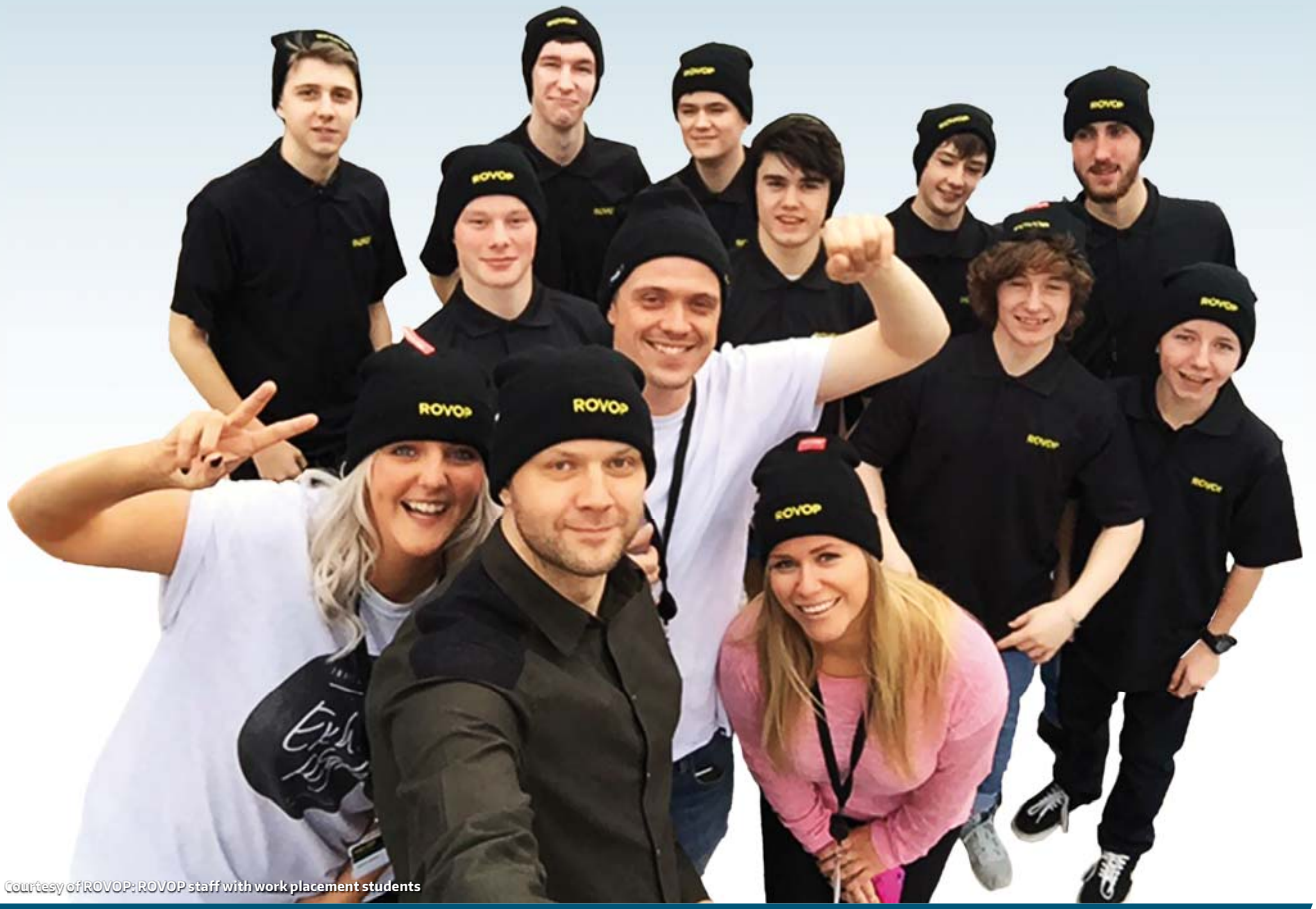
Dr. Fredrik Ryden is a founder and VP Engineering of BluHaptics, a spinoff in underwater telerobotics from the University of Washington. While Dr. Ryden believes the WCROVs of tomorrow will still have human pilots, he believes that autonomous features will greatly aid ROV operation. The ROV will be able to understand the dive plan and mission, adapt to unforeseen changes, and keep automatic logs of the mission data. Video images will be augmented by data from 3D sonar and laser scanners. Semi-autonomous operation would be particularly useful when visibility is poor. Fredrik augmented his explanation of the haptic feedback system (similar to force feedback) with a demonstration on the show floor, where volunteers assisted by BluHaptic's system used a manipulator to insert a stab into a receptacle. The system recognizes the intent of the user, and when the stab and receptacle are nearly aligned, the system "pulls" the user side into alignment.

Ian Griffiths, General Manager of SMD Americas, also spoke about autonomy in ROVs. The Distributed Vehicle Control System (DVECS-S), a collaborative development between SMD and SeeByte, enables three-dimensional dynamic position (DP) control of an ROV throughout the water column by offering five flight modes. Ian explained that DVECS-S has direct and indirect benefits, including faster transit time, increased near-bottom visibility due to the fine control of the thrusters, increased resolution of data from the stable platform, increased repeatability from the absolute survey reference, reduced mechanical wear and tear, and reduced pilot stress and fatigue.

DAY 3
MTS COMMITTEE MEETING & ROV CURRICULUM WORKSHOP

On Thursday, the third and final day of the conference, Chuck Richards held the MTS ROV Committee meeting. In 2014, the ROV committee awarded $50,000 in scholarships and supported the Marine Advance Technology and Education (MATE) International ROV competition with an additional $50,000. The committee plans to offer the same support in 2015. Another $7,500 was donated to support the "ROV in a Bag" program that has been used to teach over 1,000 students and teachers how to build ROVs. These donations are funded solely by the revenue from Underwater Intervention and we thank all those who support the conference. After covering general business, the committee continued discussions on ROV training programs. A subcommittee, led by Jill Zande, Dwight Howse, and Bob Christ, has worked with ROV contractors and potential ROV training centers toward establishing a two-year standardized curriculum to train ROV pilots and technicians. When the curriculum is finalized, the committee will share it with colleges and technical training programs around the world.

This article is just a summary of the full information shared at the conference. To get the full story, you need to attend. Even better, consider giving a presentation at UI2016. Contact the author or visit WWW.UNDERWATERINTERVENTION.COM for more information.



Courtesy of ROVOP: ROVOP staff with work placement students

WHAT DO YOU WANT TO BE **WHEN YOU GROW UP?**

That's a common question children around the world often get asked.

Yet a recent study[1] found that although four in five young people aged 14-19 have given thought to their future choice of career, almost 50 per cent felt formal careers advice simply hadn't hit the mark in helping them reach a decision. Around 60 per cent said direct advice from those already working in industry would be more helpful.

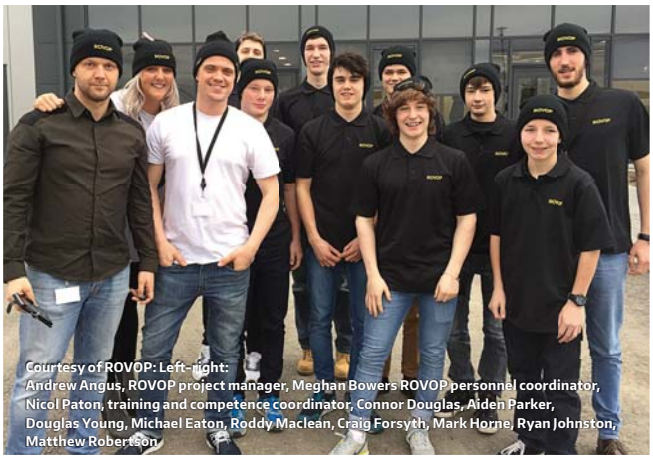
Given the projected skills gap in the oil and gas industry, it is more important than ever for employers to engage with the next generation. Perhaps more so at a time when the industry is not short of challenges. The subsea sector is a £6 billion industry in its own right with more than 800 companies employing over 50,000 people. As a critical component of modern day subsea development projects, ROVs can offer a multitude of career opportunities.

Independent Remotely Operated Vehicle (ROV) provider ROVOP has set up its own work experience programme aimed at young people from Aberdeen and its surrounding areas.

Steven Gray, CEO of ROVOP, said: "Young people today are faced with so many different options when they finish school. As a company, we pride ourselves on hiring the best

[1] The Association of Accounting Technicians (AAT) 2014

Courtesy of ROVOP: Students experiencing a taste of offshore life at industrial training centre Survivex



Courtesy of ROVOP: Left-right:
Andrew Angus, ROVOP project manager, Meghan Bowers ROVOP personnel coordinator, Nicol Paton, training and competence coordinator, Connor Douglas, Aiden Parker, Douglas Young, Michael Eaton, Roddy Maclean, Craig Forsyth, Mark Horne, Ryan Johnston, Matthew Robertson

Courtesy of ROVOP: Completing an exercise on the ROVOP Academy's simulator

people in the business from a variety of backgrounds. The aim of our programme is to show students the rewarding careers available within the ROV sector, both on and offshore. As an industry, we can't just rely on school careers services to supply the talent pipeline, we need to show young people the exciting opportunities that are available."

ROVOP was founded to fill a niche within the market for a specialist ROV services company. Since then, the company has become an established industry player by investing more than £40 million it its advanced fleet of ROVs and employing 130 people. Most recently, ROVOP moved into its purpose-built £4.2 million headquarters in the heart of Aberdeenshire's 'SURF City', Westhill. This enables the company's fleet of ROVs to be managed from one integrated site which also includes the ROVOP Academy's training facilities, office, workshop with 40 tonne overhead crane and 45,000 gallon full work class ROV test facility.

Nicol Paton, ROVOP training and competency coordinator, played a pivotal role in setting up the work experience programme. He said: "We scheduled practical sessions with every department in the company including operations, HR, finance and commercial to give a realistic picture of how a company operates but the highlight for all the students was undoubtedly our ROV training simulator.

"The training exercises are built on real-life scenarios with 3D visuals, virtual environmental conditions and challenges our ROV pilots are frequently tasked with. As well as developing their understanding of how an ROV actually works, this also tested their communication skills and showed them the importance of teamwork."

Douglas Young, a 16 year old fifth year student from Kemnay Academy, was one of the students who took part. He said: "I heard about the ROVOP work experience through LinkedIn and decided to apply immediately. There was never a dull moment and the week definitely helped me make a decision as to what career I should pursue. I gained knowledge about ROV systems, how they work and how a company like ROVOP is structured. It was a great eye opener and a brilliant opportunity."

It seems that after completing the ROVOP work experience programme, youngsters will be able to answer that common question, 'what do you want to be when you grow up" after all.

MATE INTERNATIONAL ROV COMPETITION

ROVS IN EXTREME ENVIRONMENTS: SCIENCE AND INDUSTRY IN THE ARCTIC

This issue takes a look at the mission challenges that students participating in the 2015 MATE International ROV Competitions will face in June 25-27, 2015 in St. John's, Newfoundland and Labrador, Canada. This information is a short excerpt from the competition manual, which outline the tasks, design specifications, and rules in great detail, that were released in the fall of last year.

St. John's is the capital of the province of Newfoundland and Labrador, Canada, is home to the Memorial University of Newfoundland's Marine Institute (MI) and the National Research Council's Ocean, Coastal, and River Engineering (OCRE) and their world-class facilities. MI houses the world's largest flume tank, with a water capacity of 1.7 million liters and water velocity ranging from 0–1 meters per second. The flume tank's viewing gallery has a 20 meter-by-2 meter viewing window and seats 150 people. The OCRE includes an ice tank and offshore engineering basin. In the ice tank, the water surface can be frozen and the air temperature maintained at a uniform –30 to 15 degrees Celsius to simulate the polar environment. The offshore engineering basin is used to simulate the extreme ocean environment; waves, wind, and currents can be controlled to achieve various sea states. This is where the competition will take place.

COMPETITION THEME

The polar science community and the offshore oil and gas industry are in need of remotely operated vehicles that can conduct

1) SCIENCE UNDER THE ICE

that includes counting species and sampling organisms, deploying an instrument, and collecting data about an iceberg;

2) SUBSEA

Pipeline inspection & REPAIR that includes replacing a corroded section of oil pipeline and preparing a wellhead for delivery of a Christmas tree; and

3) OFFSHORE OILFIELD PRODUCTION & MAINTENANCE

that includes testing the grounding of anodes on the "leg" of an oil platform, measuring the height of a wellhead, and controlling the flow of oil through a pipeline.

1) SCIENCE UNDER THE ICE
(international venue = ice tank)

- Maneuver through a 75cm × 75cm hole in the ice.
- Collect a sample of algae from the underside of the ice sheet.
- Collect an urchin located on the seafloor.
- Use a species identification handbook to identify and count species of sea star.
- Deploy a passive acoustic sensor in a designated area.
- Measure the dimensions of an iceberg and calculate its volume.
- Use coordinates to map the location of the iceberg.
- Use the location, heading, speed, and keel depth to determine the threat level of the iceberg to area oil platforms.

2) SUBSEA Pipeline inspection & REPAIR
(international venue = offshore engineering basin)

- Conduct a CVI (close visual inspection) of an oil pipeline for corrosion.
- Turn a valve to stop the flow of oil through the pipeline.
- Examine a gauge dial to determine that the pipeline oil pressure is zero.
- Measure the length of the section of corroded pipeline.
- Attach a lift line to the corroded section.
- Cut (simulated) the section of corroded pipeline.
- Remove the section of corroded pipeline and return it to the surface.
- Install and secure an adapter flange over both cut ends of the pipeline.
- Install a gasket into a wellhead.
- Insert a hot stab to simulate injecting corrosion prohibiter into the wellhead.

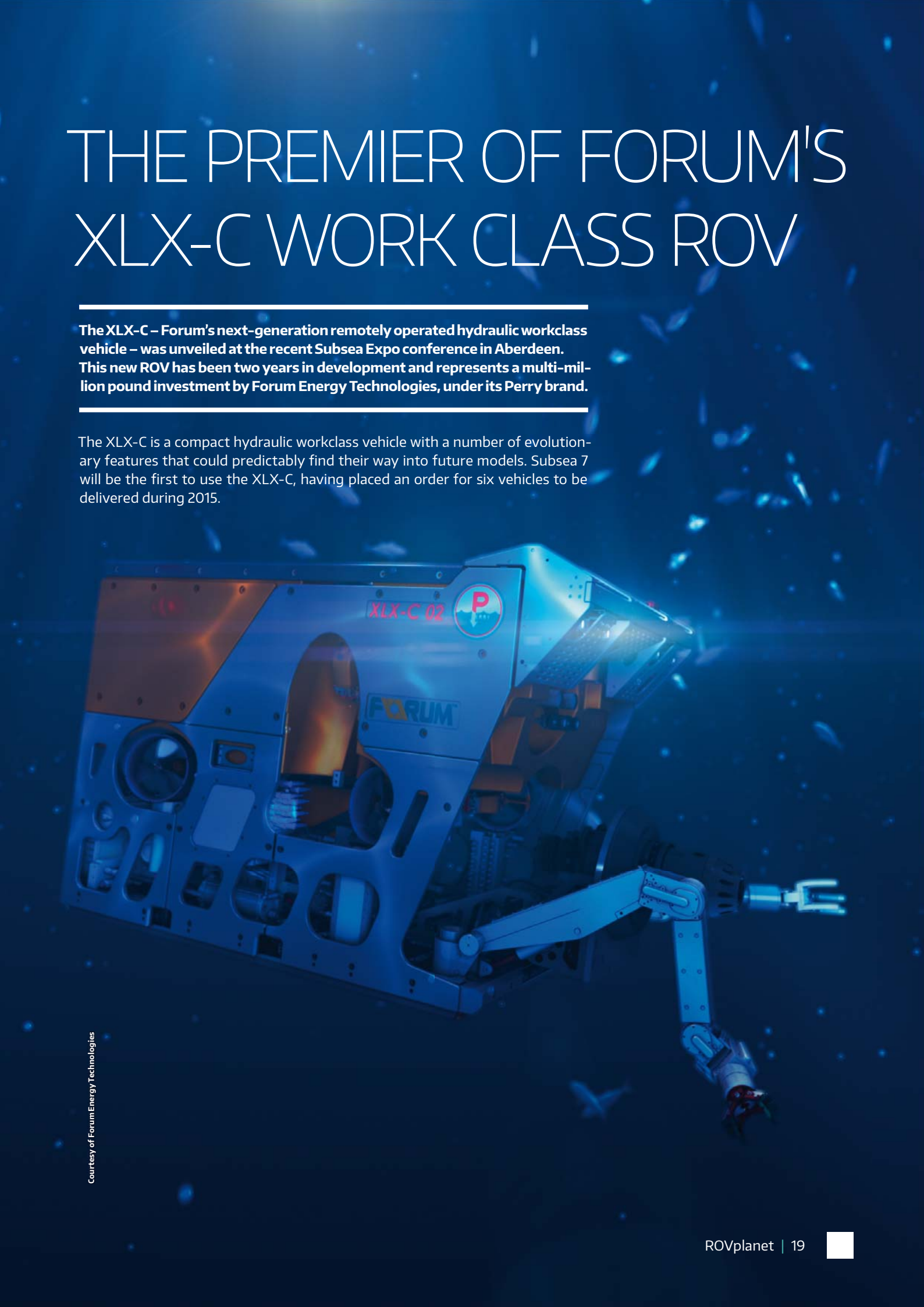
3) OFFSHORE OILFIELD PRODUCTION & MAINTENANCE
(international venue = flume tank)

- Test the grounding of anodes by measuring the voltage of specified points along the "leg" of an oil platform.
- Determine which anode(s) is not properly grounded.
- Measure the height of a wellhead from the seafloor.
- Use a map to determine the pathways of flow through a pipeline system.
- Turn valves to ensure that oil will flow through the specified pathway.
- "Push" water through the pipeline system to verify that oil will flow through the correct pathway.
- Determine the average flow rate of the water current.

THE PREMIER OF FORUM'S XLX-C WORK CLASS ROV

The XLX-C – Forum's next-generation remotely operated hydraulic workclass vehicle – was unveiled at the recent Subsea Expo conference in Aberdeen. This new ROV has been two years in development and represents a multi-million pound investment by Forum Energy Technologies, under its Perry brand.

The XLX-C is a compact hydraulic workclass vehicle with a number of evolutionary features that could predictably find their way into future models. Subsea 7 will be the first to use the XLX-C, having placed an order for six vehicles to be delivered during 2015.



Courtesy of Forum Energy Technologies

Graham Adair, Vice-president for Sales at Forum said: "We have seen strong demand within the market for an ROV sitting below the larger heavy duty workclass systems whilst able to carry out work beyond the capabilities of the larger electric vehicles. The keynotes of the new vehicle are versatility, reliability and ease of operation. It has sufficient on-board power and payload to go from, say, carrying out a survey, to work involving multiple tooling operations, quickly and seamlessly."

This new 150hp design can be viewed as the little sister to the larger XLX-EVO workclass vehicle. In effect, the new XLX-C packs the same power within a considerably smaller frame.

The XLX-C is 2.8m long, 1.7m in wide and 1.9m in height and weighs around 3600kg. Despite its compact size it still maintains a through frame lift of 3000kg more usual with larger vehicles.

The smaller surface area provides a lower resistance to underwater currents and consequently, with less weight, the thrusters do not need to use as much power to keep the vehicle on station.

The XLX-C can remain in higher currents and travel faster to the work site. The propulsion system is based on four 300mm horizontal thrusters and three 300mm vertical thrusters, manufactured by sister company SubAtlantic. These efficient and reliable thrusters give it a forward, lateral and vertical bollard pull of 850kgf.

ROVs are typically designed around an exoskeletal frame with all systems housed within the confines of this structural skeleton. But the new frame format for the XLX-C has reversed this design process.

Mr Adair explained: "A criticism routinely levelled at manufacturers by the industry is that vehicles tend to be built from the inside outwards. Maintenance and repair, conversely, tends to be carried out from the outside, inwards. While ROV designers typically locate equipment that most often needs attention, towards the periphery of the vehicle for easier access, the outer structural frame can often impede access and make the vehicle difficult to work on.

"What we have done with the XLX-C is to reverse this and design the ROV around a central frame. The components are then attached around this. Having a central structural core means there's nothing you can't access easily from outside the vehicle. There is still an outside protective shield to stop marine fauna entering the inside of the ROV, but this can be removed without affecting the structural integrity."

Mr Adair added: "The frame itself is a fully bolted design rather than welded. This means that should it ever be damaged, a part can be sent offshore for rebuilding on site, rather than having to return the entire vehicle to base. Similarly all components can be repaired on-board a vessel."

To further aid repair and maintenance, all the major components of the XLX-C are small and light enough to be removed by single-man lifts.

"We have also introduced previous advances that are proven on the EVO range," said Adair. "The electrical junction boxes were previously re-engineered for ease of maintenance and elsewhere, the power supply was redesigned to eliminate the need for a one atmospheric control can, further reducing complexity on the ROV itself.

The new system also benefits from Perry's integrated control engine (ICE) – a control system with full diagnostic capabilities providing the user with an in-depth view of the system components and sensors. The intelligent I/O system continually takes individual measurements of subsea valve coil currents, camera currents, light currents, board currents and temperatures. This allows the system to pinpoint the exact location of any problem.

"This could be a simple fault, for example, a camera that wasn't working correctly," said Adair. "It can pinpoint whether the fault lies in the camera as power or signal supply failure or in a cable."

Another feature of the new XLX-C frame design is a hydraulically actuated basket that is an integral part of the vehicle. Extending from the front, this drawer is used to store tooling which allows the manipulators to simply pick up the stored tooling and continue working. This means that once the ROV has completed a task it does not need to return to the surface to pick up new tooling which can take considerable time, particularly when working in deep water.

In addition the vehicle can incorporate work skids that include survey and bathymetric suites, suction pile systems, a jetting module and a variable ballast module.

Courtesy of Forum Energy Technologies

Courtesy of Forum Energy Technologies: The new XLX-C vehicle.

The ROV HPU and associated equipment have been evolved to rationalise components and reduce hydraulic hoses and pipework, this integrated solution also provides a more user-friendly and serviceable system whereby filters can be changed conveniently and individual components can be changed on board, further reducing the need for large expensive spare parts. All hydraulic equipment integral to the ROV is powered from a main hydraulic pump. This has a capacity of 238 litres/min at 230bar (60Hz). There is also an auxiliary hydraulic system o 120 litres/min @ 207 bar (60Hz).

Internal hydraulic distribution is carried out on the main manifold providing 10 of 12lpm proportionally controlled valves. The same manifold can be fitted to and utilised by the auxiliary circuit. In addition to this, high flow output can be provided by a new valve pack providing 2 of 75lpm or 140lpm bi-directional control, these can also be utilised for torque tool operation were the control is integral to the ICE control system, negating the need for additional control manifold.

The on-board electronics provide a wide range of options for video, serial, power and fibre optic channels. A typical system can have twelve standard definition real-time composite video channels as well as 6 individually dimmable light channels, with three or more high definition cameras. There are dedicated serial and power channels for controls, valve packs, gyro, depth, altimeter/DVL, sonar etc.

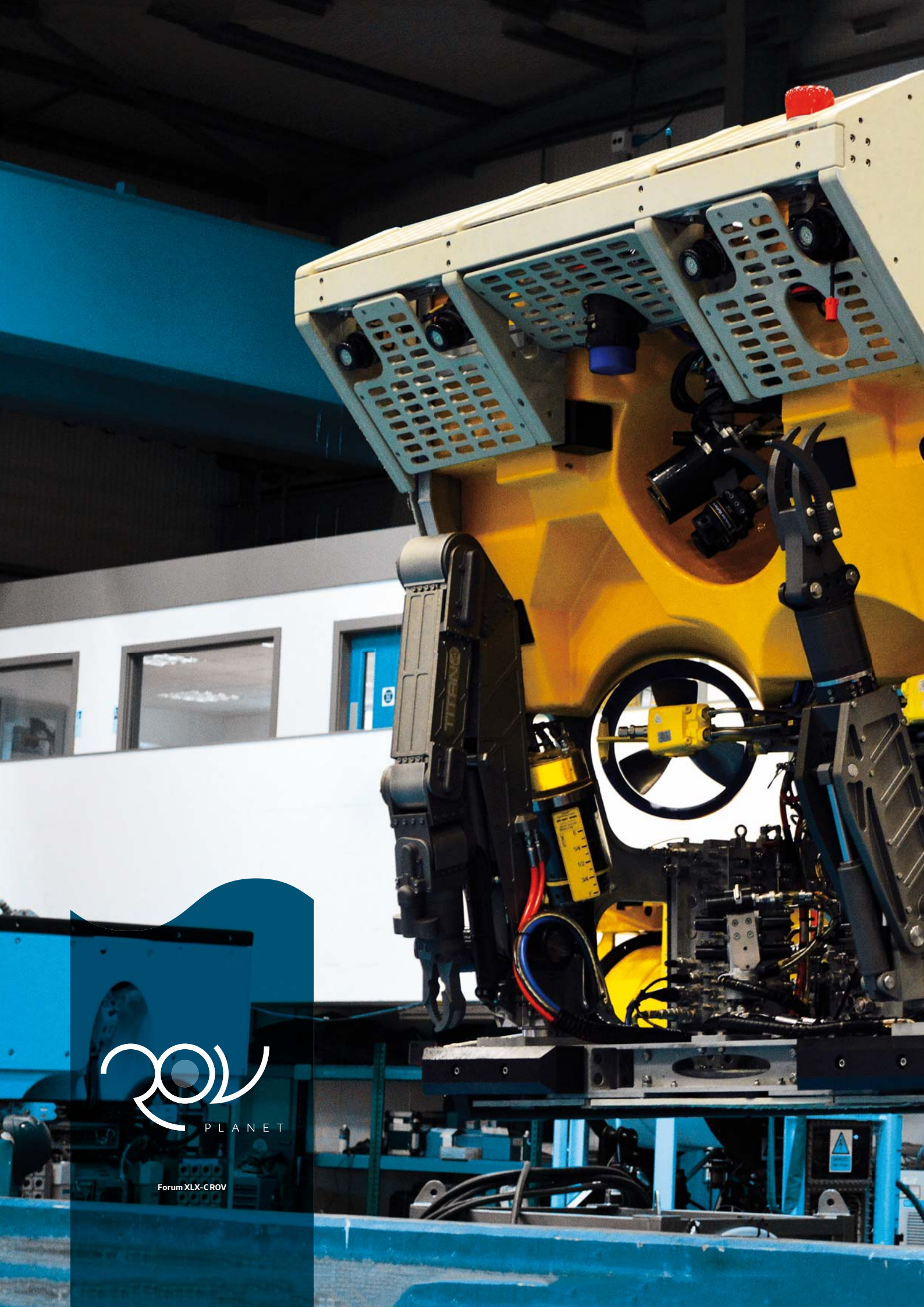
The system typically incorporates up to 7 spare RS232/RS485 serial channels, three single mode fibres and twelve spare CWDM Channels. Current monitoring and protection systems are incorporated on each power channel.

The XLX-C can be fitted with an array of advanced sensory equipment such as multibeam or obstacle avoidance sonar, acoustic cameras. To assist navigation, there is a heading, pitch and roll (fibre optic gyro) sensor, depth sensor (with an accuracy of ±0.01%) and a Doppler velocity log.

Vehicle piloting is assisted by auto heading and depth systems including altitude, park, and dynamic position. Its heading control is accurate to ±1deg, pitch and roll control up to ± 5.0deg, depth control up to ±150 mm and altitude control up to ±150 mm.

Forum's range of in-house manufactured Dynacon launch and recovery systems (LARS) include designs particularly suited to the XLX-C, offering compact lay down areas and ease of road transport. The XLX-C has options to be deployed using A-Frame, cursor or crane jib head pulley LARS and in addition the main umbilical can be supplied with either armoured or soft configuration.

A tether management system (TMS) is used to decouple the ROV from motion of the surface vessel and enables it to operate at a larger radius from the launch location. The XLX-C is fully compatible with Forum's proven range of Perry TMS. It can be supplied with either a garaged or top hat TMS – typically a type 4 (up to 440m of 35mm diameter / 750m of 27mm diameter tether). An alternative configuration available is a type 5 system with up to 750m of 35mm diameter / 1150m of 27mm diameter tether.



ROV PLANET

Forum XLX-C ROV


PERRY
XLX-C 03
FORUM

SURVEYOR INTERCEPTOR

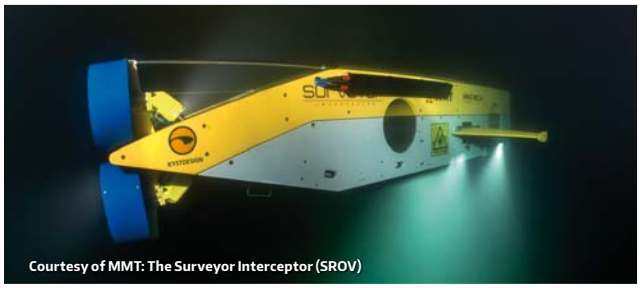
MMT and Reach Subsea have recently finalized successful offshore tests on the new Surveyor Interceptor ROV from the vessel Edda Fonn. The results were above all previous expectations.

Ola Oskarsson, founder and project manager for Surveyor Interceptor ROV (SROV),explains in his report the reasons behind the sea trials with the new SROV. He and his team collected background data for a specialized handling system, to test speed, maneuverability, stability, and cable drag, as well as data quality and density.

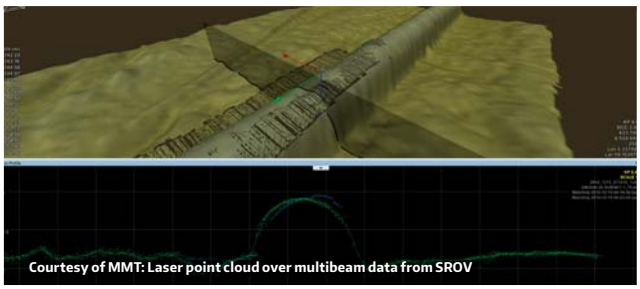
'It is a very competent machine' Oskarsson says of the new SROV, 'operating faster than WROVs and AUVs with unsurpassed accuracy and data quality. The vehicle is robust and can operate for long periods underwater thus being a tool to make pipeline surveys and inspections more effective.'

Oskarsson explains that the result of the tests demonstrates that they have been able to reach the design speed of 8 knots. The vehicle produces high density data at 6 knots, and 4 knots when operating close to pipe. The SROV – as a survey platform – is very stable, and multibeam data has less than 0.4% noise.

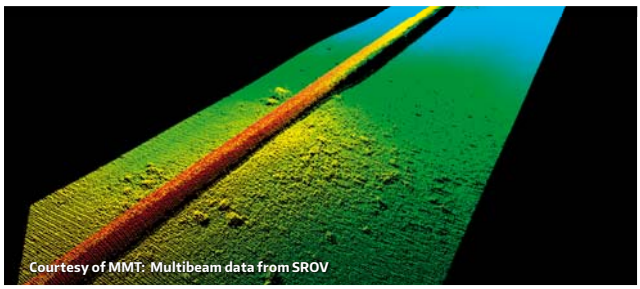
As you can see the sea trials of the SROV are very encouraging, and have produced some great results. We will be producing full coverage on the vehicle in one of our future issues.



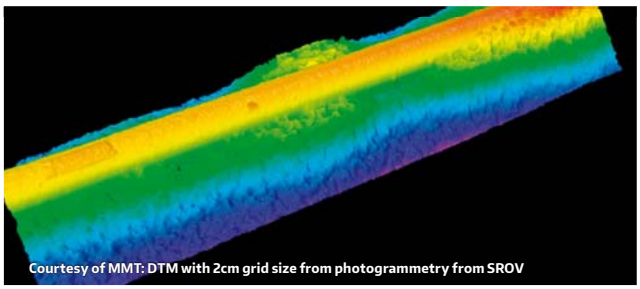
Courtesy of MMT: The Surveyor Interceptor (SROV)



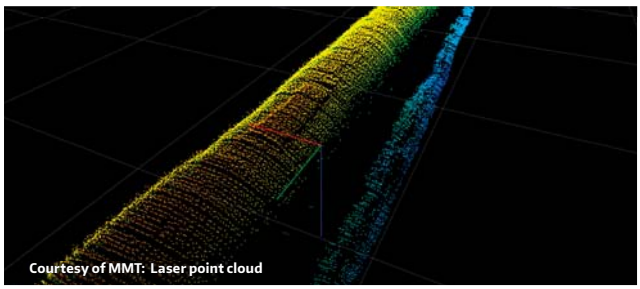
Courtesy of MMT: Laser point cloud over multibeam data from SROV



Courtesy of MMT: Multibeam data from SROV



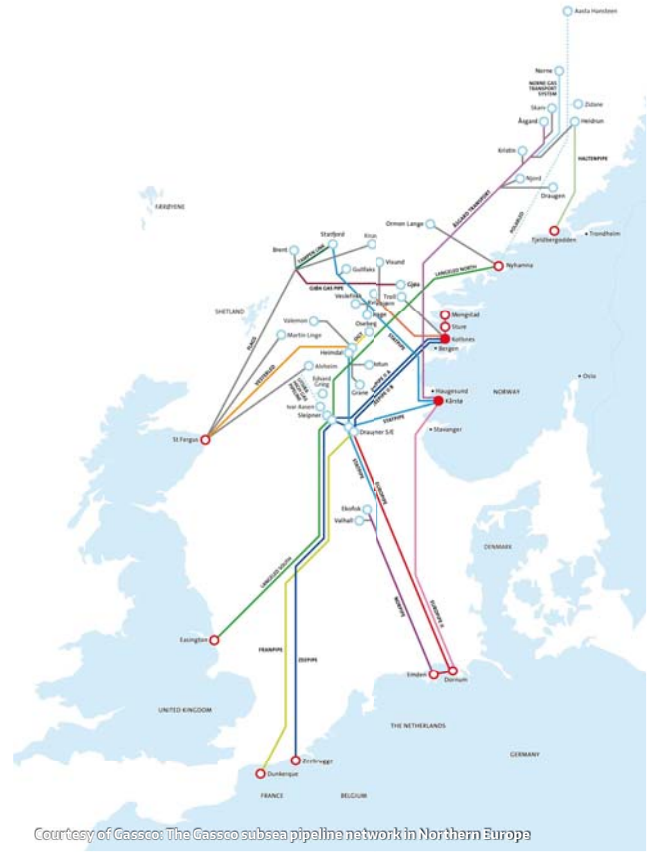
Courtesy of MMT: DTM with 2cm grid size from photogrammetry from SROV



Courtesy of MMT: Laser point cloud

As operator, Gassco has several duties: to serve as the administrator who ensures safe and effective gas transportation, and to be the architect who ensures that the transport system is developed in an integrated and cost-effective way. The integrated Norwegian gas transport system is connected to all major gas-producing fields on the Norwegian Continental Shelf (NCS). The integrated transport system is also connected to major downstream gas transmission systems in Europe and the UK.
Kristin Kinn Kaste, VP Transport Network at Gassco, explains why the Surveyor Interceptor looks like the ideal vehicle for subsea pipeline inspections:

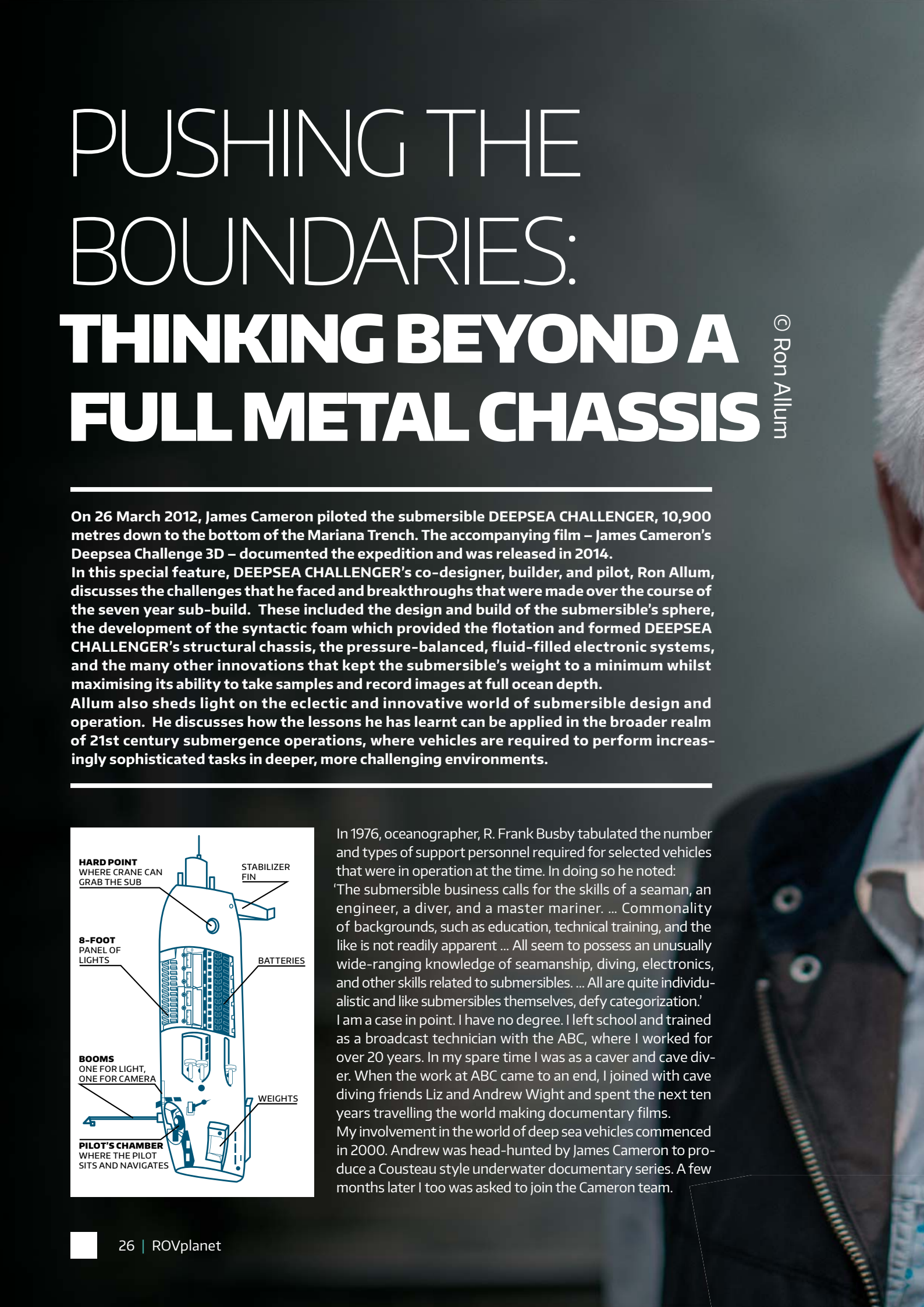
'A safe and effective gas transportation system is essential to secure gas supply to Europe. As we are responsible for 8,000km of pipelines, Gassco is continuously seeking cost effective and high quality solutions to ensure robust condition monitoring of these pipelines. The majority of the pipelines are located subsea and are being externally inspected by vessels/ROVs. Vessel/ROV operations are cost demanding, and factors that influence pipeline inspection costs are typically related to vessel specification, speed of the ROV to be used, technology, and methods and optimization of the inspection campaign/interval. Gassco has therefore developed a strategy to optimize these factors to improve cost effective external pipeline inspection. New technology and methods that support this strategy are appreciated. Hence, Gassco has supported both testing and use of the new ROV developed by MMT.'



Courtesy of Gassco: The Gassco subsea pipeline network in Northern Europe

PUSHING THE BOUNDARIES:

THINKING BEYOND A FULL METAL CHASSIS



© Ron Allum

On 26 March 2012, James Cameron piloted the submersible DEEPSEA CHALLENGER, 10,900 metres down to the bottom of the Mariana Trench. The accompanying film – James Cameron's Deepsea Challenge 3D – documented the expedition and was released in 2014.
In this special feature, DEEPSEA CHALLENGER's co-designer, builder, and pilot, Ron Allum, discusses the challenges that he faced and breakthroughs that were made over the course of the seven year sub-build. These included the design and build of the submersible's sphere, the development of the syntactic foam which provided the flotation and formed DEEPSEA CHALLENGER's structural chassis, the pressure-balanced, fluid-filled electronic systems, and the many other innovations that kept the submersible's weight to a minimum whilst maximising its ability to take samples and record images at full ocean depth.
Allum also sheds light on the eclectic and innovative world of submersible design and operation. He discusses how the lessons he has learnt can be applied in the broader realm of 21st century submergence operations, where vehicles are required to perform increasingly sophisticated tasks in deeper, more challenging environments.

In 1976, oceanographer, R. Frank Busby tabulated the number and types of support personnel required for selected vehicles that were in operation at the time. In doing so he noted:
'The submersible business calls for the skills of a seaman, an engineer, a diver, and a master mariner. ... Commonality of backgrounds, such as education, technical training, and the like is not readily apparent ... All seem to possess an unusually wide-ranging knowledge of seamanship, diving, electronics, and other skills related to submersibles. ... All are quite individualistic and like submersibles themselves, defy categorization.'
I am a case in point. I have no degree. I left school and trained as a broadcast technician with the ABC, where I worked for over 20 years. In my spare time I was as a caver and cave diver. When the work at ABC came to an end, I joined with cave diving friends Liz and Andrew Wight and spent the next ten years travelling the world making documentary films.
My involvement in the world of deep sea vehicles commenced in 2000. Andrew was head-hunted by James Cameron to produce a Cousteau style underwater documentary series. A few months later I too was asked to join the Cameron team.

For the next few years our second home was the Russian cold war ship Academic Keldysh, and our offices were her twin 6,000 meter rated submersibles, Mirs 1 and 2. In that time we filmed two 3D, IMAX films and two TV specials. For the latter I designed a fibre optic link and broadcast system for a live telecast. James Cameron was in Mir 1, 3,800 metres deep and positioned over the grand staircase on RMS Titanic where the stained glass dome used to be. From there he was able to describe his experience and show images both of the inside of Mir 1 and of Titanic to a live US audience. He also controlled a remotely operated vehicle that worked its way down the grand staircase, and several more levels to show the audience the Turkish bath rooms on her F deck. These rooms had never been photographed or filmed before.

We first discussed a full ocean-depth submersible in 2002, but it was not until the successful live broadcast that Jim (James Cameron) asked me to take the project on. From the start Jim made it clear that that he did not want a conventional submersible. Amongst other things it had to be:

- fast in vertical descent and ascent to maximise bottom time;
- be large enough to house at least one pilot and a high definition camera;
- weigh less than 10 tons so it could be deployed from an affordable ship of opportunity;
- capable of collecting samples and conducting scientific experiments, and bringing back 3D images from the deepest trenches on the planet.

Developing the submersible was one thing; turning it into a filming platform was even more challenging. To meet the target weight meant starting with the smallest pilot capsule possible.

Photo by Randy Larcombe. Courtesy of Ron Allum Deepsea Services.

The most efficient shape to withstand the crushing pressure at 11,000 metres deep was a sphere, but even so it was going to be heavy. The volume we finally chose was about the same size as a family freezer: about 730 litres. As well as pilot, the sphere had to contain life support, control electronics, computer screens, 3D, HD recorders, plus appropriate clothing and a heated suit for emergencies.

Again, to save overall vehicle weight, we needed to use higher energy density batteries. However there was no space left inside the sphere for the submersible's batteries or the high power electronics required for the battery management system, motors, and our powerful LED lights. I also considered it unwise to house them in such a confined space with a human occupant. As we did not have capacity to carry additional heavy pressure vessels, I designed lightweight plastic boxes for lithium polymer batteries and electronics. They were then fluid filled, compensated, and had to work at pressure.

At the same time I set to work designing the sphere. Our initial sphere design utilised titanium alloy. However, we found that few titanium forges in the world would take on a small, one-off project, and those who would quoted exorbitant costs for tooling. Furthermore, in 2006 the global economy was booming, and the War in Iraq had sparked a surge in demand for munitions and aircraft parts by the US military.

I was fortunate enough to be referred to a Victorian metallurgist – Ross McNeil of Bureau Veritas – who suggested we build the sphere in steel and manufacture it in Australia. I commissioned Finite Elements in Huonville Tasmania who provided finite element analysis and project engineering support. We sourced gun-barrel steel in Newcastle and had it forged in Albury. Then, the resulting two giant discs were pressed into hemispheres and machined in Melbourne. The hemisphere heads were welded together in Adelaide, and when finally in one piece the sphere was heat-treated back in Albury. The completed sphere was shipped to Pennsylvania State University's Applied Sciences Laboratory, where it finally passed pressure test in September 2009.

My focus then turned towards sourcing the flotation for the sub: the syntactic foam. The foam is usually made up of a mix of hollow glass microspheres and epoxy resin, which sets solid like a brick but floats. Again I turned towards the US and requested quotes and samples. Again I hit a wall. I was either given no-response, was told the samples I tested were not homogeneous, or that they offered an insufficient factor of safety, especially for a piloted vehicle. With their standard foam we would have to incorporate a chassis that would make our sub too heavy. Furthermore, if a foam block failed during a dive the pilot and sub might not ascend.

Rather than abandon the project, I went to a Kitchen Warehouse in Marrickville and bought a food mixer. It took me 12 months to come up with a structural flotation material that we could use. From there we designed a manufacturing plant and commenced production in February 2011.

By that stage we had electronics working in fluid and at pressure. The sphere passed her pressure test and the syntactic foam formula was sound. It was then that Jim released significant funds and I was finally able to call in additional resources. I say with great pride that the staff, consultants, subcontractors, and suppliers I hired were resourceful, innovative, and outside-the-square thinkers. Furthermore, most were recruited from an available talent-pool in Australia.

Richard Stanning of Mona Vale Boat Builders, McConaghy, developed a method to bond our syntactic foam blocks together. They normally think 'high tensile strength' but had to think opposite: 'high compressive strength'. Large syntactic foam sections were machined at Chipping Norton based Williamson's and at Taren Point based C.A. Rich. Neither company had worked with syntactic foam before.

Perth based Oceania L-3 designed an acoustic communications module for full ocean depth operation that worked with a NATO submarine surface unit. These worked in tandem to provide data and voice communication and navigation for us. Balmain's based Design and Industry came up with an innovative sub internal design to fit Jim and all the equipment that I mentioned previously into something akin to a small chest freezer. Botany based Mo Milling churned out parts for our thruster motors and other assemblies. Our electronic assemblies were brought together in St Peter's based Dayang facility. The list goes on.

In less than 12 months from the time we started our manufacture of the syntactic foam, DEEPSEA CHALLENGER performed her maiden dive at Garden Island docks on Australia Day 2012. A month later, Jim took her to 8,220 metres off the coast of Rabaul.

On March 26 he achieved his dream: taking DEEPSEA CHALLENGER to 10,900 metres in the Mariana Trench off Guam. The expedition film James Cameron's Deepsea Challenge 3D was subsequently released in 2014.

So what was learned from the seven year project? There were many things. From my perspective the technological breakthroughs that can be applied to other areas were:

- a pressure tolerant, high energy density battery system;
- pressure tolerant power electronics with serial control systems;
- a propulsion unit with pressure tolerant integral driver;
- improved comfort by incorporating a 'whiffle ball' internal sphere;
- revised life support system using electronic oxygen injection;
- custom penetrators designed for high definition camera signals, high speed data, and RF feed throughs;
- the use of structural syntactic foam to provide floatation and structural integrity in one package;
- a 11,000mtr operation.

The next question is how can these lessons be applied in the broader realm of submergence operations? To my mind the heavy metal chassis – albeit aluminium or titanium with separate float pack – has dominated ROV/AUV and submersible design for too long. Structural syntactic foam

can be screwed, glued, and laminated: a single material for both jobs. Furthermore, its ingredients can – amongst other things – be tailored to enhance ballistic protection or change its fire retardant properties.

Likewise, similar lessons can be applied to battery packs. In the same way that cordless tools now dominate the building industry, batteries can replace the need for surface supplied power on ROVs. Just think: the use of lithium polymer batteries could negate the need for a heavy umbilical, tether management system (TMS) and/or deck winch. This in turn means that vehicles can be deployed from smaller, more cost effective vessels than are typically associated with work-class ROV's/AUVs and submersibles.

As for depth, there is no reason that vehicles should be limited to a 6,000 metre rating. On this point, both the Australian and United States governments have placed high priority on maintaining a safe, secure and prosperous Asia/Pacific region. This vast area encompasses some of the deepest waters on our planet. The sea floor drops to around 5,000 metres just 60 nautical miles off Sydney Heads. Off Australia's resource rich North West coast, it reaches over 7,000 metres. Off New Guinea, the Solomon Islands, and Tonga it drops to over 8,300 meters. Off the North Island of New Zealand is the Kermadec Trench; a trench which some believe to be deeper than the Mariana.

As for me, I'm pleased to say I was able to retain the test chambers and some of the equipment used to build DEEPSEA CHALLENGER. I now work with government and industry bodies interested in innovative concepts for new semi-autonomous and autonomous underwater vehicles, from littoral to hadal depth. It is stimulating, satisfying work.

I'm often asked if given the opportunity to build another full ocean depth submersible would I do it all again. In the last three years I have been a free spirit and have formulated in my mind many new and exciting advances that could be made. If I was given the opportunity to construct a vehicle built on these ideas then yes, I would do it in a heartbeat.

Photo by Randy Larcombe. Courtesy of Ron Allum Deepsea Services.

THE SCIENCE BEHIND

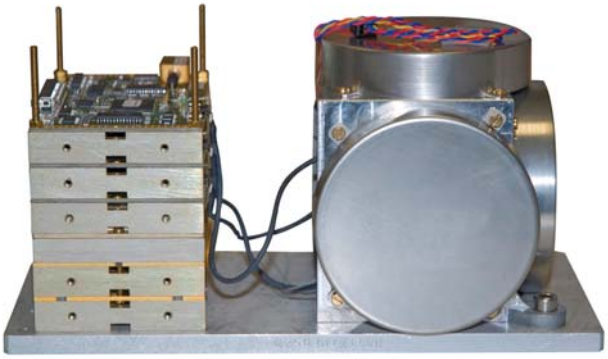
INDUSTRY LEADING ROV POSITIONING

iXBlue is a world-leading provider of navigation, positioning, and imaging solutions on or around land, sea, subsea, or in space. Offshore Technical Manager Jim Titcomb and Commercial Manager Hubert Pelletier detail the firm's state-of-the-art fibre-optic gyro technology, inertial solutions, and underwater acoustic systems, and the wide range of applications in which they can be used in Remotely Operated Vehicle (ROV) operations.

iXBlue's range of Subsea Fibre-Optic Gyroscope (FOG) based inertial navigation offerings – with advanced multisensor data fusion capabilities – are designed to address the unique challenges of shallow and deep-water offshore projects, down to depths of 6,000m.

FOG TECHNOLOGY

iXBlues FOG (Fibre Optic Gyroscope) technology is the driving force behind a range of products that are very well known in the ROV industry. The OCTANS gyrocompass is by far the widest used high grade gyrocompass in use on the world's ROV fleet. Based on the same technology are the PHINS, ROVINS, and OCTANS NANO, as well as GAPS: a pre-calibrated acoustic positioning system.



Courtesy of iXBlue: The Internals of an OCTANS

The FOG is a totally solid-state technology with no moving parts; there is no maintenance or calibration requirement. It can withstand extremely demanding mechanical environments without compromising its performance, and is particularly insensitive to mechanical shock.

iXBlue (formally iXSea) started work on FOG technology in 1987, by leveraging fundamental research performed on FOG technology that iXSea's founders had carried out for many years before. In 1997 the first viable FOG based product, OCTANS, was released. OCTANS is a gyrocompass and motion sensor which can provide true heading pitch, roll, yaw, heave, surge, sway, rates of turn, and accelerations. OCTANS is capable of finding North to an accuracy better than 0.1 degree.secLat, and has 0.01 roll and pitch accuracy.

In 2000 iXSea took FOG to the next level by introducing the PHINS (PHotonic Inertial Navigation System). PHINS uses the same technology as OCTANS, but with more accurate fibre optic coils. The motion can be measured with greater accuracy: so long as you know the starting position, you can calculate any subsequent position. This is the basis of Inertial Navigation.

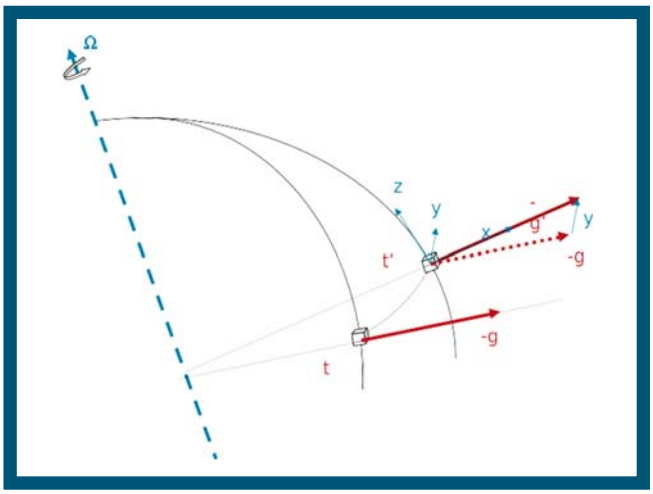
SAGNAC

Key to the operation of a FOG is the 'Sagnac effect'. Georges Sagnac (1869-1928) was a French physicist, and in 1913 he proved that the speed of light is independent of the speed of the light's source. He proved this by creating an experiment which generated an interference pattern with light that was passed through a ring of mirrors. He showed that the interference pattern varies with the speed of rotation of the mirrors. In a modern FOG, the mirrors are replaced with a coil of optical fibre and the light source is an LED.

To fully understand the principles of a FOG, you need to imagine the light beam being split into two and injected into either end of the fibre coil. If there is no rotation then the two beams of light will follow the fibre path round the coil, pass each other at the halfway point, and emerge from the opposite ends of the coil at the same time. Now if we repeat the operation but the coil is now moving, the rotation of the fibre will 'help' one pulse and 'hold back' the other. Now when the light pulses arrive at their respective exit points, one will have traveled a little further than the other, and they will arrive at slightly different times. In actual fact, this is an oversimplification of the effect, but it should help the reader to understand what is going on. The actual effect is due to relativity, and a good full explanation can be found at the web site http://www.physicsinsights.org/sagnac_1.html.

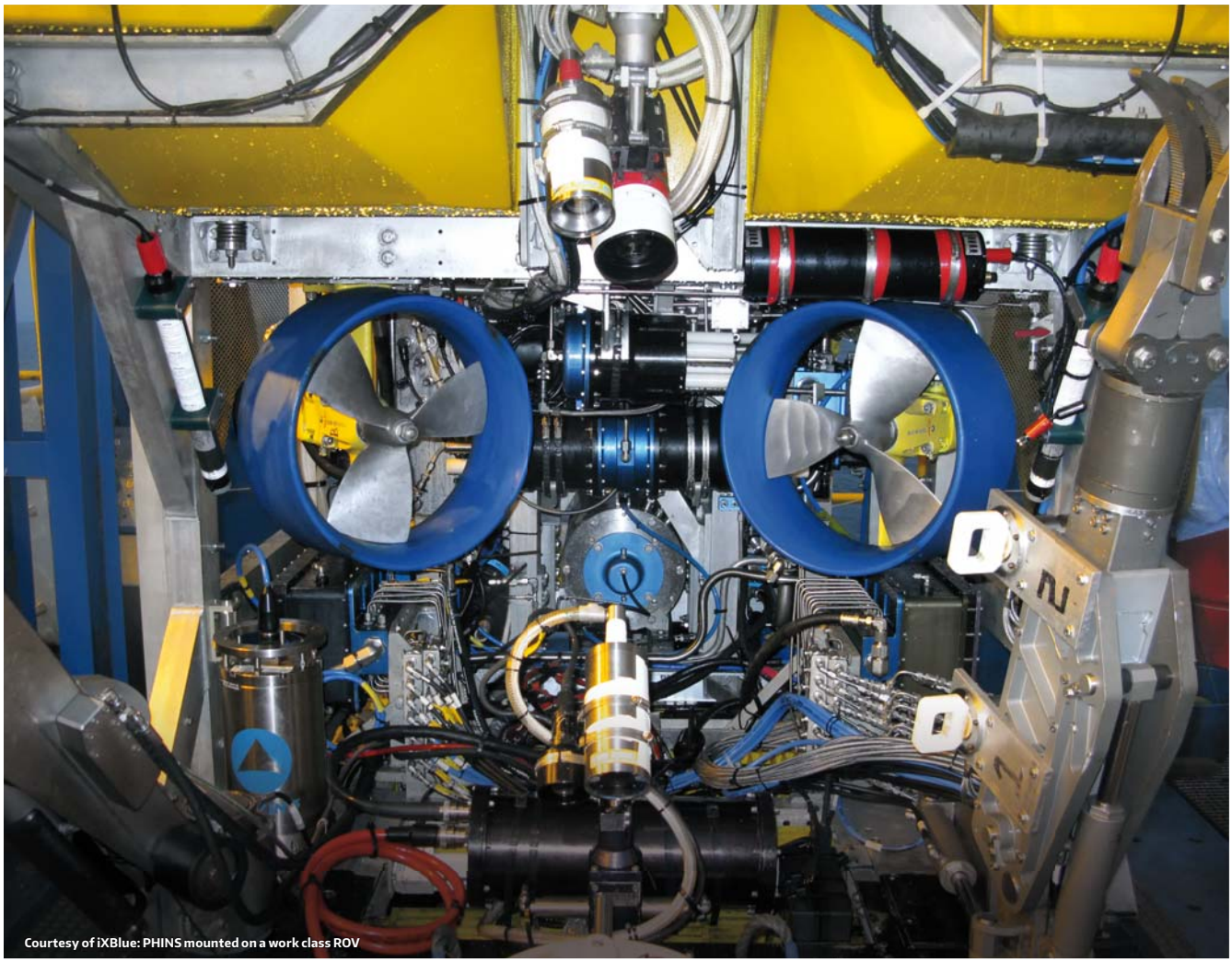
FINDING NORTH

A solid state gyro compass such as OCTANS is made up from three fibre optic gyroscopes and three linear accelerometers which together make up the Inertial Measurement Unit [IMU]. Any gyrocompass finds north by sensing the rotation of the earth. This is achievable because the three FOG's allow the unit to measure an inertial reference frame independent of the instrument rotation (the inertial reference frame). The direction of gravity is measured using the accelerometers. As the earth rotates the direction of "down" changes with respect to the inertial reference frame. North is at right angles to the direction of change in Gravity.



INERTIAL NAVIGATION

An Inertial Navigation System (INS) takes that a step further, by mathematically processing the heading with the accelerations and rotations. If the measurements are accurate enough, it is possible to navigate from a known starting point.
The process of turning the accelerations and rotation rates into positions is a two stage process; the accelerations are integrated to give speed, then integrated again to give displacements from the last position. Errors will build up in the process. The acceleration errors add to the velocity over time, meaning that the velocity will build up if not corrected by external inputs.



Courtesy of iXBlue: PHINS mounted on a work class ROV

The effect of these errors is that over the short term an Inertial Navigation System is very accurate. However, the speed builds up slowly at first and becomes quicker as time progresses.This means that it will ultimately produce an exponential error on position. The main error factor in an inertial solution tends to be speed, so by interfacing a speed sensor such as a Doppler Velocity Log (DVL) the errors in the speed can be corrected. This allows the user to turn an INS with a drift rate of 0.6Nmi/h, in to one where the error is 0.1% of distance traveled (1m for every 1km).

AIDING AND THE COMPLETE SOLUTION

As well as the Doppler Velocity Log mentioned above, aiding for iXBlues INS can be provided by its own range of acoustic positioning systems. These include GAPS or RAMSES, but also third party systems like pressure sensors, sound velocity sensors, HiPAP® and other USBL systems: even LBL.

Conventional high performance subsea positioning solutions rely on acoustic methods, either measuring the range and bearing to a device, or measuring ranges to multiple known points. As ranges increase, the update rate slows and accuracy degrades. Acoustic positioning systems tend to have a slow update rate and a noisy ('jumpy') position, but over the long term the average position can be very accurate.

We have seen how an Inertial Navigation System is almost the complete opposite of an acoustic positioning system. The position from an INS has a high update rate, is very smooth, but over time it drifts.

iXBlue have mastered the technology behind both Inertial Navigation and Acoustic positioning. By fully understanding both technologies iXblue can make the best of combining them.

INERTIAL only + **ACOUSTICS** only = **A PERFECT COMBINATION**

When an Inertial Navigation System receives external data, it is used not only to correct the INS position. The algorithm in the INS's (Kalman Filter) makes use of the corrections to estimate the error of its internal sensors. In this way, over time and with more aiding data, the INS becomes even more accurate.

"iXBlue have developed a range of solutions for the most demanding applications: robust to temporary acoustic communication hazards, extremely accurate, without drift, and with the highest data rate. These are the iXBlue building blocks."

iXBlue have developed a range of solutions for the most demanding applications: robust to temporary acoustic communication hazards, extremely accurate, without drift, and with the highest data rate. These are the iXBlue building blocks.

The positioning 'building block' architecture provides simple-to-use and scalable solutions, using some or all of the iXBlue underwater positioning sensors – PHINS, ROVINS, GAPS, RAMSES, etc. – with additional third party components as required, such as USBL, LBL, DVL, pressure sensors, and sound velocity sensors.

This approach can act as a key component for up-to-date subsea positioning systems. The advantages of such an approach are threefold:

- The advantages of each individual technologies is kept while the disadvantages are discarded.
- Redundancy and hence robustness is provided.
- Flexibility is ensured, as the the system architecture can be set to meet the specific needs of one given application.

RAMSES AND PHINS/ROVINS: THE PERFECT COMBINATION

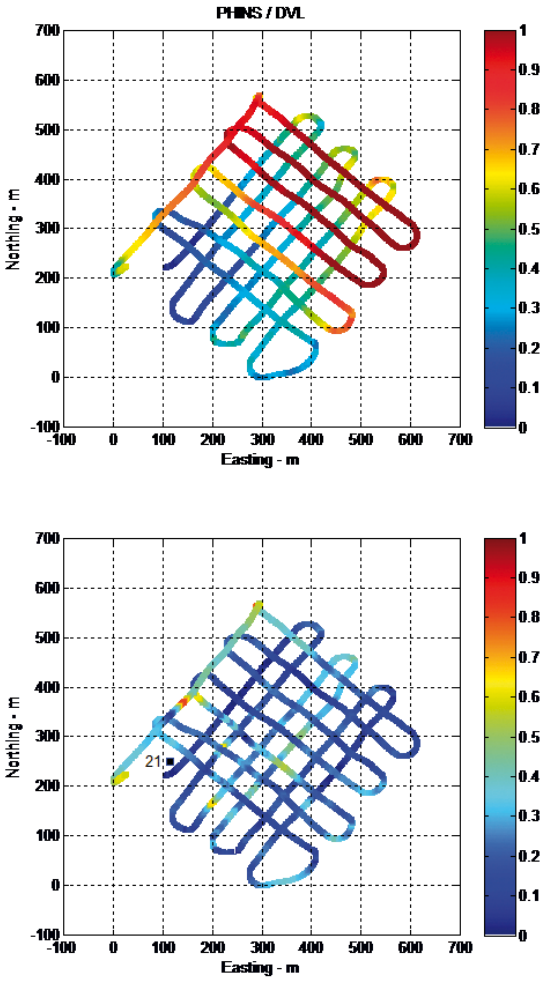
RAMSES is a Synthetic Acoustic Base Line (SABL) positioning system. In basic terms, SABL is a system which is able to interrogate transponders and receive replies using range meters or transceivers, with iXBlue or third party transponders. RAMSES also includes the processing capability to calculate positions based on these ranges without requiring a topside system. RAMSES includes a Kalman filter, and so is able to integrate external data with the ranges to the transponders – such as a DVL and a pressure sensor – to further enhance the calculated position.

When integrated with an iXBlue INS, some unique capabilities become possible. When connected to a ROVINS or PHINS the system is able to calibrate transponders (SLAM algorithm), then use a reduced number of them – SPARSE ARRAY, starting from one or two – to provide a decimetric accuracy positioning at high update rate, whilst remaining extremely robust to ambient conditions.

In order to further improve the flexibility of this solution, iXBlue acoustic systems in the MF range (GAPS, RAMSES MF) are now able to operate with third party wide bandwidth transponders.

APPLICATIONS

Example 1: Sparse Array Navigation



PHINS (ROVINS) is simply coupled to RAMSES (no additional software/hardware required) to allow SPARSE ARRAY navigation.

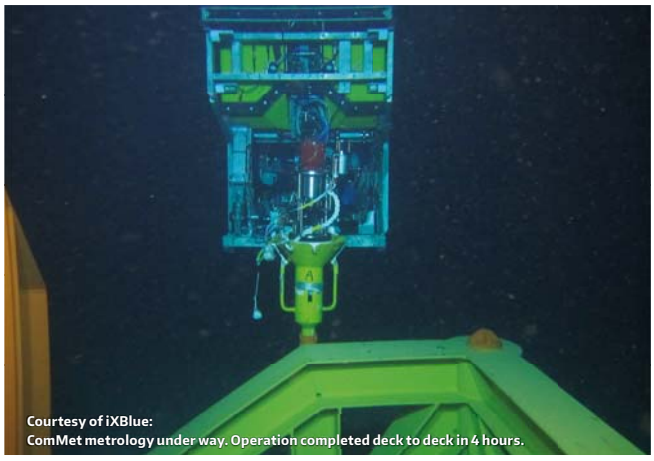
The examples below demonstrates the massive improvement in accuracy brought to a 700x700m grid survey, using RAMSES and only one transponder (right) compared to the same set-up with high performance INS/DVL only (PHINS)

Example 2: ComMet, the smart metrology solution

ComMet combines in a single tool PHINS, RAMSES, ancillary sensors, and a full software suite. With no calibration required, only three transponders are used for the metrology: one at each end and a third reference unit. Following this clear and simple procedure, the ROV navigates around the metrology gathering acoustic ranges to the transponders. Masking of the acoustic beacons is not a problem for the system, as the huge number of acoustic ranges gathered from all angles means that large sectors can be obstructed and viable results can still be achieved.

After the ranges have been gathered the PHINS is used to measure the attitude of the connection points. Processing of the results generates multiple redundant measurements, the consistency of which is an indicator of the quality of the operation.

Commercially deployed in West Africa, the North sea, and South East Asia, ComMet metrologies typically take around 4 hours from deck to deck, in around 1,000m of water. On the Bonga NW field in west Africa, 8 metrologies were achieved in one 49 hour period.



Courtesy of iXBlue:
ComMet metrology under way. Operation completed deck to deck in 4 hours.

Courtesy of iXBlue

SUMMARY

Based on the number of inertial systems sold for use in offshore applications and customer feedback, iXBlue is currently the world leader in ROV navigation technology. OCTANS led the way in establishing the benefits of solid-state (non magnetic) heading sensors, and today OCTANS Nano continues that trend of innovation, bringing the smallest subsea gyrocompass to the market. Major operators now increasingly demand the use of high-performance Inertial Navigation System – such as ROVINS and PHINS – to ensure efficiency in critical subsea operations. OCTANS, ROVINS, PHINS, and the new OCTANS Nano now sets the bar for performance and reliability in their respective classes.
The acoustic positioning business has grown year-on-year, and has received excellent feedback in terms of performance, reliability and robustness in extremely challenging environments. The third party inter-operability of GAPS and RAMSES releases has also been praised.
Customers often confirm the key metrics associated with iXBlue products for them are performance, robustness, reliability, time saving, and lowering total cost of ownership (TCO). Clients demand higher integration, quantifiable solutions, and better technology and iXBlue responds with novel products that build on the success of the basic building blocks to simplify complex operations such as metrology or sparse array navigation.

FIND US

iXBlue are delighted to welcome you to visit them at Ocean Business (booth H9) or indeed contact any of the team operating in any of 15 global offices spread across 6 continents. To find out more please visit www.ixblue.com

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BAXTER THE ROBOT:

REDEFINING ROV MANIPULATION

At ROV Planet we are always excited to decipher new and emerging technologies that have yet to break through the offshore gateway, which either fuses, or rejects non-offshore technologies in to its existing framework. One particular innovation that has the potential to create such a break through is Rethink-Robotics' Baxter system.

Baxter traces its roots to the Massachusetts Institute of Technology (MIT) and is currently used in line manufacturing. It is a highly unique system that can be trained to carry out tasks within minutes without complex programming, by physically touching and manoeuvring its manipulators. This feature clearly distinguishes it from current ROV manipulator technology, which requires an ROV pilot to engage a specialized joystick attached to a Master Control System (MCS) in order to operate an ROV's arms. Because of the striking differences between these two technologies in regards to manipulator engagement—joystick versus the human touch—Reaching Ultra's Fernando Hernandez and Santiago Moros synthesized their distinct robotics and automation backgrounds to give a forward thinking analysis of Baxter. They give demonstrative examples as to how this cutting edge technology, which differs from current ROV methods and technology, can add value to the offshore industry.

BAXTER AND ITS INCEPTION

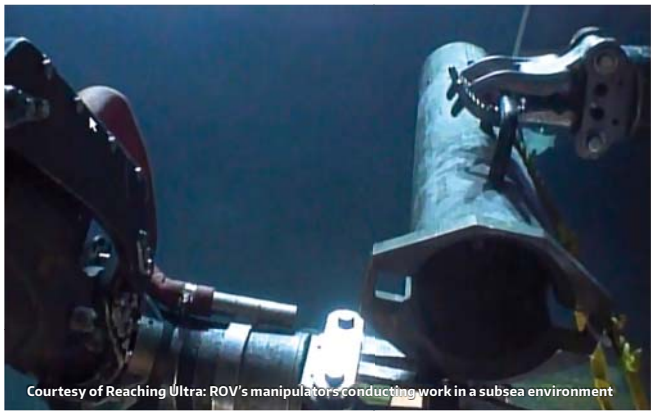
Baxter was launched in late 2012, and was spear-headed by MIT's own robotics professor, Dr. Rodney Brooks. In addition to his role in robotics development, Brooks was also the director of the institute's computer science and artificial intelligence laboratory. Moros explains, 'It was during his tenure at MIT, that Dr. Brooks cultivated behavior-based technology, a core element of Baxter, which incorporates programming a robot by physical interaction.'

Courtesy of Guilherme Duque: ROV and ROV pilot shaking hands

Courtesy of Reaching Ultra: Technician removing a hot stab after pressure testing a receptacle


Courtesy of Reaching Ultra: Hernandez carrying out work on an ROV


Courtesy of Gavan Hennigan: Saturation diver performing underwater work


Courtesy of Reaching Ultra: ROV's manipulators conducting work in a subsea environment

Moros continues, 'I first began interfacing with Baxter, during the early stages of setup and classroom integration at Humbor College, prior to graduating as an Electro-Mechanical Engineering Technologist in 2014.' He adds, 'After intense hands-on interaction with Baxter, I began to realize that Baxter had more to offer to the world of robotics apart from line manufacturing.'

Hernandez, who has extensive subsea intervention and ROV operations experience adds, 'The more Moros and I discussed Baxter, the more I was drawn to this technology, as I had never seen anything like it in the ROV and subsea industry. The idea that Baxter can be trained via human hands to carry out tasks by way of its manipulators really opened my eyes; just as striking is its ability to memorize tasks.

'What further piqued my interest was the fact that Baxter's arms have 7 degrees of freedom, with accompanying end-effectors that can be changed out on command to adapt to the project at hand.' Moros begins detailing how Baxter does not require complex programming or coding. He points out that Baxter can begin working autonomously after being trained in less than an hour.

'What permits Baxter to be trained with such swiftness lies in the fact that each of its arms have torque, position, and velocity sensing in each joint, allowing for zero-gravity like manipulation of its arms when its cuffs are maneuvered by an operator. The operator simply guides Baxter by the cuff, and the robot moves seamlessly.

'The maneuvers performed are then inputted on to Baxter's arm, so as to have it memorize the maneuver. Doing this does not require a programming background; a non-automation mechanic can quickly perform this.'

ASSEMBLY AND DEMONSTRATIVE EXAMPLES

Hernandez begins to highlight Baxter's assembly capabilities. 'The fact that complex programming is not required means that a technician can quickly train Baxter to assemble semi-complex ROV tools. Baxter can also be used for training purposes, whereby workers with minimal subsea experience can observe the robot performing tasks in a repetitive fashion, so as to become acclimated with the work they are to perform.'

'This greatly redefines training, as it brings training documents and manuals in to the real world. Furthermore, in an assembly setting, each arm along with its assigned end-effector can be trained independently of the other arm, increasing its efficiency once it begins to perform its duties.'

Moros explains that from a safety standpoint, Baxter is very human friendly and is engineered to sense when dynamic changes take place in its environment and working envelope. 'Because Baxter can interpret changes in its environment, it can quickly correct its movements. For example, if the robotic arm inadvertently makes contact with a wall, its collision detection features greatly reduce the force of impact with said wall.'

Hernandez continues with the theme of assembly, as he explains how each of the robot's arms can have different styled manipulators/end-effectors installed on to them, so as to have Baxter properly adapt to the task at hand.

When asked what advantages this could bring, he replies, 'By outfitting an offshore specific Baxter system of the future with class 1-4 type end-effectors, it will allow it to easily manipulate and function valves attached to ROV buckets, during Factory Acceptance Tests (FAT).'

Hernandez is quick to point out that in order for the aforementioned to be carried out, fit for purpose modifications are required. This, however, does not deter him from showing further applications for Baxter. 'In addition, it can also be used in a Quality Control (QC) role, where it is trained to insert 17H hot stabs in to matching receptacles, to check for insertion anomalies, allowing a separate Baxter system to hydraulically pressure-test the hot hot stabs which have passed a QC check. And it is during such pressure-tests that Baxter's "health & safety" benefits come to light, as it ensures that personnel are not in contact with energized equipment.'

SITS AND FATS

Pressure testing subsea accumulators during an FAT, requires the release of hydraulic fluid at high pressure and flow rates. This, in turn necessitates having to use a safety first mentality, explains Hernandez.

'In order to release the hydraulic fluid, an accumulator requires the use of one of the following engagement methods: employing acoustics, a mechanical link, or operating a manual valve. And in a situation where the acoustic and mechanical link options fail to set off the accumulators, a technician must employ the manual option, which must be carried out carefully, because of the risks associated with this option.'

'For this reason, Baxter is an ideal candidate for such duties: it keeps technicians and engineers out of the line of fire should a catastrophic failure cause hydraulic fluid and mechanical parts to expel in a volatile fashion. Moreover, Baxter can also be of high benefit on R&D projects that require installing and removing electrical wet mate connectors that are transmitting high voltage.'

Hernandez begins explaining how this technology can also be of value in regards to System Integration Tests (SITs). 'During SITs mock up ROVs with manipulators are attached to cranes. These mock up ROVs are then flown in and around subsea assets while equally checking the ROV interface points. Because Baxter can also be controlled remotely via a PC with dedicated software, this allows Baxter to test interfaces on assets while having aerial mobility. '

INTERACTIVE FEEDBACK

When Moros is asked to elaborate further on how Baxter interprets its surroundings, he explains how Baxter is designed to adapt and understand objects in space, as well as colors and shapes in its environment.

'Baxter can equally accept and interpret external stimulation, which is similar to how we humans interact with our own environment. This is achieved via Baxter's front camera, infrared technology, and 360 degree sonar sensors. The information that is collected from the aforementioned components is then processed via an onboard central processing unit.'

Moros explains further, saying, 'Baxter's human-like interaction, coupled with its simple facial expressions, gives its user a full understanding of the machine's status though an on board Human Machine Interface (HMI) monitor, which has the ability to make facial expressions. Moreover, by tracing the movements of the robot's eyes via the HMI, a technician can know what the robot will do next in a sequential task, as the robot looks to its next point of interest. In addition, when Baxter is touched, the Robot's HMI looks for the source/point of contact.'

'Furthermore, facial gestures, such as a sad face, allow an operator to know when Baxter is not operating optimally. The screen equally gives the user an additional point from which to configure Baxter. ' Hernandez adds, 'The fact that Baxter is able to sense where it has been touched/impacted, and its ability to have its digital face look for the point of contact, makes this system truly exceptional. '

'Conversely, when an ROV inadvertently bumps in to a subsea asset, the pilot must turn the camera to see what was

Courtesy of Reaching Ultra:
Moros engaging Baxter, as the Robot looks for next point of manoeuvre

Courtesy of Reaching Ultra: Moros guiding Baxter by way of its cuff

Courtesy of Reaching Ultra: Baxter's HMI displaying a displeased face

bumped or grazed. Imagine an ROV pilot having an external digital face mounted on an ROV, and it being automatically able to look for the point of contact on the pilot's behalf, while advising the pilot that its tether has become "snagged" by displaying an upset face.' Keeping with the theme of self-awareness; Hernandez details how Baxter is also able to keep track of each arm in relation to the other, ensuring no collisions occur between the two.

DIVING SECTION

Hernandez adds, 'I firmly stand behind master controls systems and ROV manipulators, as their track record and contributions to the offshore world speak volumes. However, if we can learn how to repurpose Baxter, it's a win-win situation for the industry.'

Hernandez believes that the commercial diving industry as a whole can equally benefit from Baxter, due to diver's having to be resourceful with their energy. This he explains is something that he learned the hard way. 'When I was assigned to oversee the subsea portion of a rigless P&A in 750' of water, I called out for saturation divers to perform tasks the way an ROV would do in deepwater. Because of this, the dive superintendent reminded me that machines (ROVs) do not get tired. From that point on I applied a resourceful approach, in regards to a diver's movements and energy.'

Hernandez explains that the potential is there for Baxter to serve as an additional tool in a diver's toolbox of the future, especially in a situation where a diver requires additional assistance or when a repetitive task needs to be carried out during a bell run. 'A diver would have to train Baxter in a submerged environment, but the human-based interaction remains. To do this in a subsea environment would require making fit for purpose and subsea modifications.' Hernandez points out how the offshore industry has shown it is more than capable of doing this, Norway's Åsgard project being a key example of this.

APPLYING THE ONSHORE OFFSHORE

Hernandez explicates how the offshore industry has demonstrated its propensity for solving problems, and synthesizing different technologies to arrive at a cutting edge solution. This, he explains, is exemplified not only by Åsgard, but also via MOBOT, the first offshore specific ROV launched in 1969 off the coast of California to work on subsea wells.

Hernandez notes that before MOBOT was used offshore, it worked in radioactive environments on land for the Atomic Energy Commission. 'MOBOT is the embodiment of what happens when non-offshore technologies are accepted by the offshore realm's technological framework, as highlighted by MOBOT's ability to override valves on a subsea stack. Presently, the ability for ROV's to carry out the aforementioned has become of the utmost importance after the Macondo incident of 2010. However, and more importantly, 40 years prior to such incidents, MOBOT's engineers designed MOBOT to perform such actions.'

Now the question is what can we, as an industry, do with Baxter to benefit future operations?

Courtesy of Connect Subsea: Mock up ROV with manipulators in an SIT

BLUE ROBOTICS

PROPELLING THE FUTURE OF MARINE ROBOTICS AND OCEAN EXPLORATION

Courtesy of Blue Robotics: Joe Spadola, Rusty Jehangir, and Josh Villbrandt during the sea trials of the SolarSurfer

Their interest in underwater thrusters started as a side project for Joe Spadola, Rusty Jehangir, and Josh Villbrandt. The trio came from varied and promising backgrounds. Jehangir grew up in Chicago. After studying aerospace engineering (B.S.) and control systems (M.S.) at the University of Southern California, he joined a team designing, building, and testing a large-scale gas-powered multicopter for use by the military. Spadola came from Phoenix, and studied mechanical engineering at Arizona State University. He has worked on computational fluids dynamics and thermal analysis of jet turbine engines, designed and built autonomous vehicles, consumer product design, and fatigue analysis. Villbrandt hailed from Los Angeles, and is an avionics engineer at SpaceX during the day. He studied aerospace engineering (B.S.) followed by intelligent robotics (M.S.) at the University of Southern California and has built autonomous ground robots, quadcopters, airplanes, and now marine robots.

Courtesy of Blue Robotics: The BlueROV

Courtesy of Blue Robotics: Joe Spadola and Rusty Jehangir with the SolarSurfer

Courtesy of Blue Robotics: The first manufactured T100 underwater thruster (SN: 00001)

As you may have already guessed, the one thing that they all had in common – besides their shared love of the sunny beaches of California – is a passion for robotics. They came up with an experimental concept. They wanted to attach solar panels, a GPS unit, a micro-controller, and thrusters to a surfboard and send it from Los Angeles to Hawaii. Completely autonomously.

The team were able to find all the components they needed without any problems, except for the thrusters. So they had two options. The cheap option was to use regular brushless motors without additional protection. Unfortunately, they would corrode and break long before the surfboard made it to Hawaii. The expensive option was to use commercial-grade thrusters designed for commercial ROVs, but these ranged in price from $500 to $3,000. This was way outside of their meagre hobbyist budget.

Neither option seemed great. However there was a third option: design the thrusters themselves. 'We started with the traditional thruster design, a motor enclosed in a tube, but soon realized that there was a simpler, better option,' explains Jehangir. 'We designed a motor from the ground up that runs completely immersed in water without corrosion or shorting.' According to the team, this helped reduce cost and eliminated traditional pressure limitations.

After some initial prototyping with a 3D printer and a lathe, the team won the 'Proto Labs Cool Idea!' award, in April 2014. The prize money paid for the injection molding tooling to make the thrusters possible. After some initial prototyping with a 3D printer and a lathe, Spadola, Jehangir, and Villbrandt launched a Kickstarter campaign to raise the funds to cover the rest of the cost of thruster construction. To those unfamiliar with Kickstarter; the website is a global crowdfunding platform with a mission to help bring creative projects to life. A minimal funding goal has to be met by the backers within a certain timeframe in order for the project creators to unlock the funds. In Blue Robotics' case the target was set at $35,000. They started the campaign on 12th August, 2014 and on 11th September they closed donations with 360 backers, $102,685, and 293% of their goal.

Since then, the trio have finalized their designs and started shipping, the first batches of the T100 thrusters to their backers and customers; they have already shipped around 900 T100 thruster units to ROV enthusiasts around the World. The T100 thrusters can be used in a variety of underwater applications, including being installed as an upgrade thruster for OpenROVs. The team took their idea to the next level by designing their own BlueROV. 'Our goal is to provide affordable enabling components to make marine robotics more accessible to customers around the world.' says Jehangir. As such, their ROV uses six thrusters, and on the topside it's controlled via a laptop running an open source code and an Xbox controller.

With their product being very well received by underwater robotics fans around the world, the future looks very positive for Spadola, Jehangir, and Villbrandt. The team have big plans for Blue Robotics, including finishing production of the T200 Thruster, a more powerful version than the T100, despite having very similar dimensions. Also, they have already started developing a waterproof and water-cooled electronic speed controller for their thrusters. Having already produced such exciting concepts within a short space of time, I'm sure we're all very excited to see what Blue Robotics will do in the near future.

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