ROV PLANET

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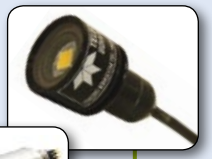

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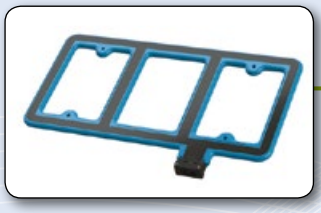

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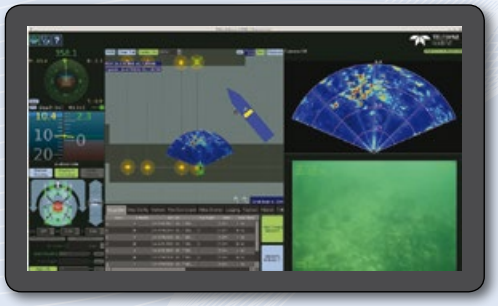

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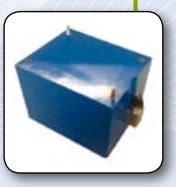

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WELCOME TO ROV PLANET

My name is Richie Enzmann, and allow me to welcome you all to the latest issue of ROV Planet!

Dear Reader,

2018 has taken off with a great start and with a very positive outlook for the future. I can feel the excitement in the air with the prospect of new projects being sanctioned and contracts awarded in the offshore oil and gas domain.

In this issue we take a look into the field of underwater cinematography. Two companies in the forefront of technological innovation have simultaneously and independently developed a new class of ROV for the underwater world: the "Cinema Class ROV". All Oceans have developed the MAC-ROV and Marine Imaging Technologies have developed the Pixel – these two ROVs are both aimed to be valuable tools for any future underwater cinematographer, documentary maker, and underwater adventurer that would want to share their underwater activities with a wider range of audience. Although, as you will read, the "TV Studio Shuttle" is only one of many configurations the MAC-ROV Shuttle system is capable of. It is a versatile system that has many configurations to support the "Blue Economy", including subsea mining support, and is rated for deep-water applications down to even 6,000m.

In our untethered autonomous column Robert L. Wernli, Sr. explains why we should cut the tether and he gives interesting and thought provoking definitions to the term of ARCTIC exploration. And then we take a look at the wide range of services that the PLOCAN underwater research centre has to offer for the underwater vehicle sector.

Finally, we have launched the Parts & Equipment Suppliers section of the ROV Planet Buyer's Guide 2018. You can find the online version on our website via clicking on the "ROV/AUV Parts & Equipment" web banner and there are also printed copies available. If you would like to have your company listed please get in touch and we can add you to the online version initially and then to the print version when we re-run the prints later on in the year.

Best regards,
Richie Enzmann

UPCOMING EVENTS

6-8 February, 2018 – Underwater Intervention (UI) – New Orleans, LA, USA
The world's premier event for Commercial Diving Contractors, Remotely Operated Vehicles, and Manned Submersibles.

7-9 February, 2018 – Subsea Expo – Aberdeen, UK
Europe's largest annual subsea exhibition and conference

13-15 March, 2018 – Oceanology International – London, UK
The world's leading ocean technology marine science exhibition and conference.

9-11 April, 2018 – MCEDD – Milan, Italy
World-class technical discussions focusing on the offshore technology, innovation and experience.

30 April – 3 May, 2018 – Offshore Technology Conference (OTC) – Houston, TX, USA
The World's largest annual offshore exhibition and conference.

26-28 June, 2018 – Undersea Defence Technology (UDT) – Glasgow, UK
The underwater defence & security community's most relevant exhibition and conference.

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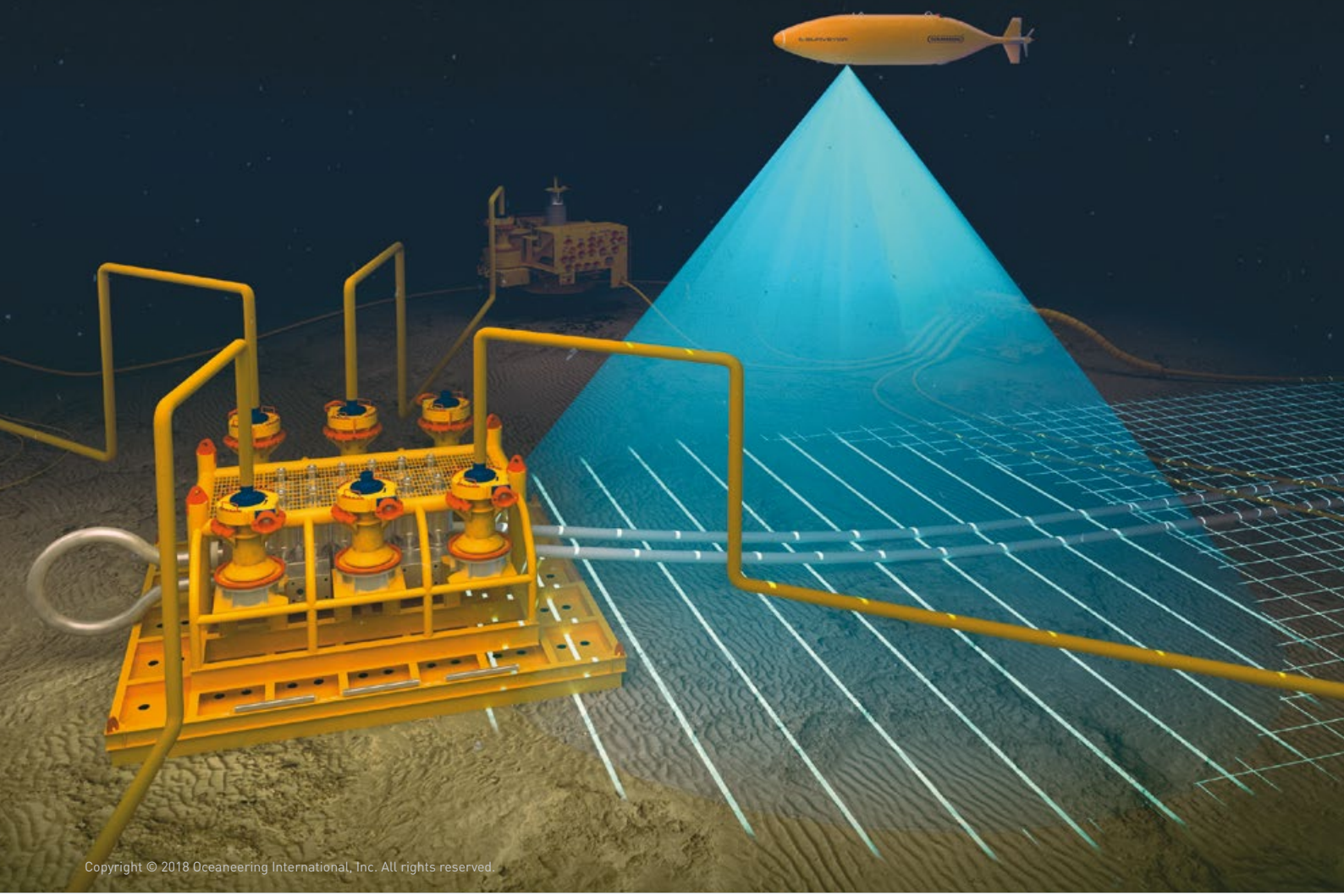

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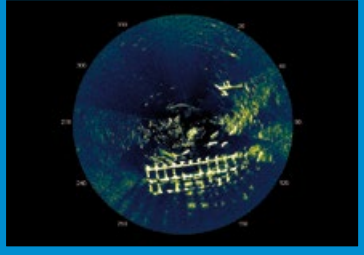

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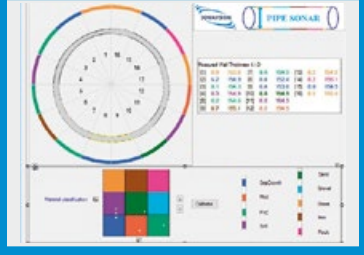

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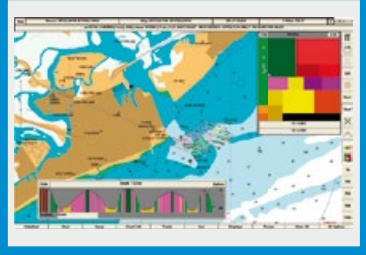

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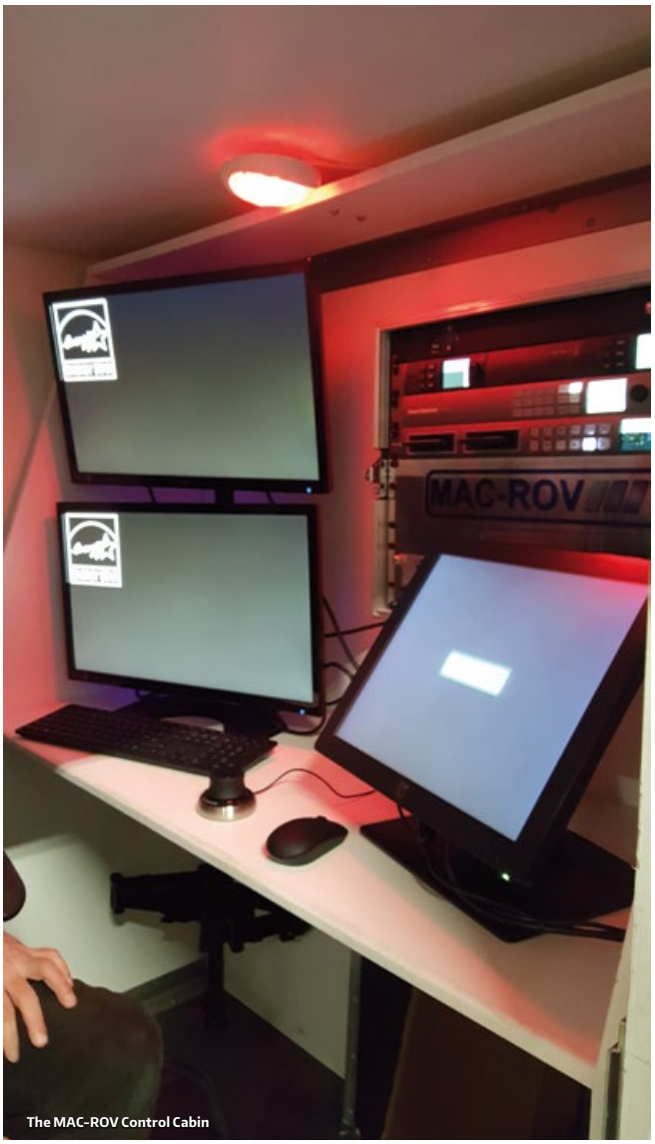
UNDERWATER CINEMATOGRAPHY USING THE MAC-ROV SHUTTLE SYSTEM

Brian Abel,
Managing Director, All Oceans

The underwater world still has a lot to improve to satisfy the hunger for good video production, as it is still at the point where the only way to get a shot underwater is to have a camera and a light on one transport mechanism. However, in a studio environment lights are always completely separate entities from the cameras in order to not experience any reflection issues. On top of this, the quality, quantity and types of cameras and lights required differ from the needs of industrial applications. It also takes time to develop a scene when juggling between the different lighting options and camera angles, therefore having two separate ROVs in the water simultaneously has its own advantages.

The MAC-ROV Vehicle (Courtesy of All Oceans)



The MAC-ROV Control Cabin

ALL OCEANS are pleased to announce that the MAC-ROV has now arrived and is focused on enabling the Blue Economy with 4K visualisation, discovery and recovery, from the surface to 6,000m. On its own it is a work system, but doubled up and packaged with flexible lighting it's a TV studio, underwater.

The standard MAC-ROV has a 4K camera and three HD cameras and the "TV Studio" system can deploy and process three times this amount, split over three separate independently controllable platforms. There is also the option to integrate any third party manufactured cameras if a film maker has a preference to any specific manufacturer. Equally, there are several different interface options available for integrating additional equipment to the system.

The MAC-ROV deployment options range from "Tow and Throw" live boat type systems to 1,000m. Fly-out systems to 6,000m for mounting to bigger host submersibles such as work class ROVs and mining machines. Then surface deployed "Shuttle" systems providing mission flexible payloads to 6,000m and the "TV Studio" option.

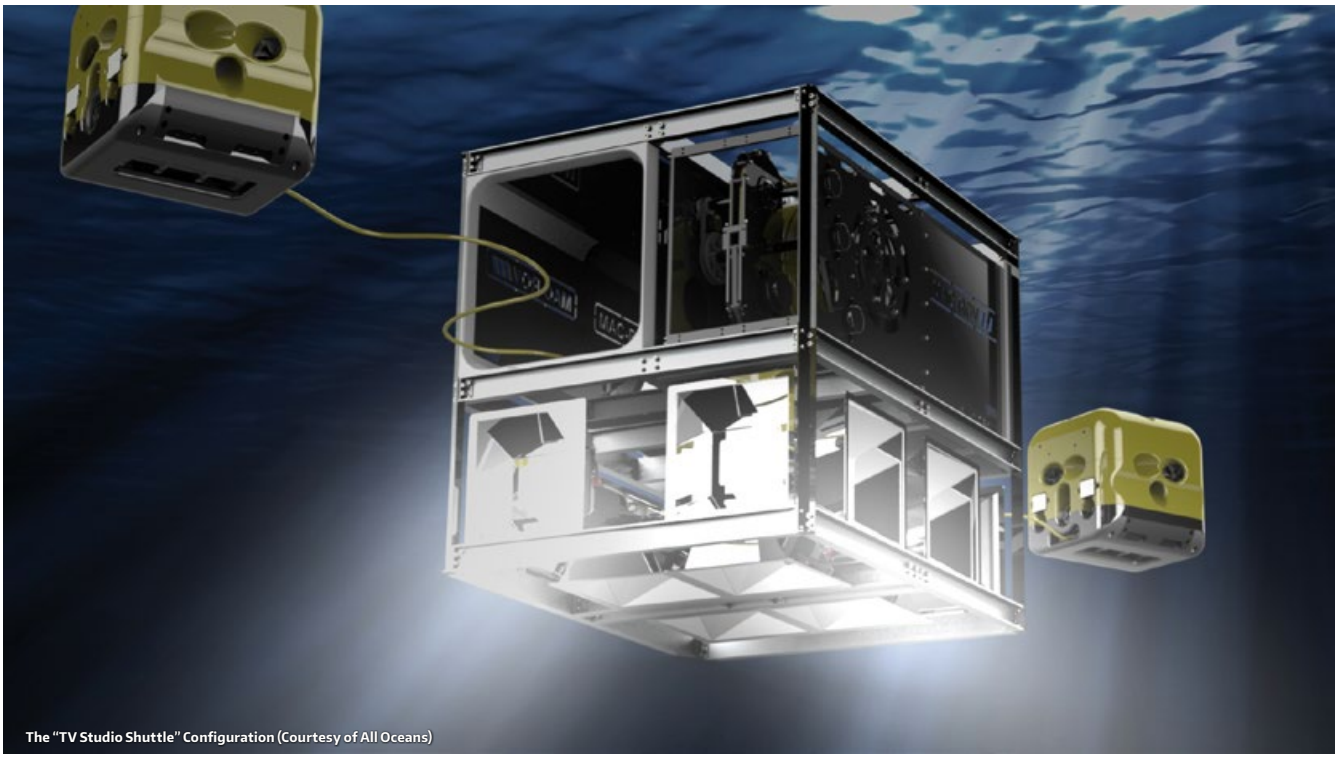
The unique approach of the "Shuttle" system allows for opportunities that didn't exist before by any other means. It is a high capability under water solution in a small and lightweight package. Both the overall system weight and the power requirement are around one tenth if compared to a typical work class ROV with a TMS. This in turn reduces the size of the boat that is needed resulting in lower manning, costs, and risks – it all comes together. This whole system could easily fit onto a 40-50m boat, compared to 80m+ of the typical systems. However, in certain cases even a 25m long boat could be viable with the deck installed system of 6-tonnes. The only risks you get with going on a smaller boat are the waves and the weather windows for deployment.

The "Shuttle" system is simply a Launch and Recovery package with a 1Te x 3g rating. The Shuttle itself is a simple open frame with three power points each rated to 5kW (a MAC-ROV is 4kW), and a telemetry hub that can handle the output from 3 x 4k and 9 x HD cameras real time to the surface over more than 6,000m of umbilical cable.

Previous experience and lessons learnt from the All Oceans product line were taken into consideration in the design of the MAC-ROV. Initially, the system was intended for subsea mining operations where aggressive acidic environments are present and the correct TMS design was one of the key enablers to keep the size down of the shuttle system. The first TMS delivered by the company in the early 90s are still operational to this day, which is due to the clever design and the high quality materials being used in the build. The shafts are hard chromed stainless steel and the roller-bearings used are contained within oil filled housings to prevent the ingress of dirt into the bearings. All Oceans never had to replace a single shaft despite a lot of these TMS working in drilling rig support operations where oil based muds and grits are present. The reliability of the TMS system is important because the risk of TMS failure in these missions is not acceptable.

It was also important to keep down the number of spare parts required for the system and minimise complexity. To keep this principle in mind the TMS slip ring is identical to the topside winch slip ring and both are fitted with underwater connectors inboard and outboard. This allows for easy interfacing and change outs and avoids the need for separate stationary and rotary junction boxes.

Another interesting feature of the MAC-ROV is the six degrees of freedom control that allows unlimited options for cinematography. In the future, with the right software and control, the pilot could fly the ROV on a pre-defined camera route. Joystick (manual) flight control would be more associated with getting the vehicle on site in the first instance and moving between sites or scenes; in simple terms, more control and manoeuvrability, with less reliance of piloting skills. For example, flight control would be programmable so stable sideways (panning) and even



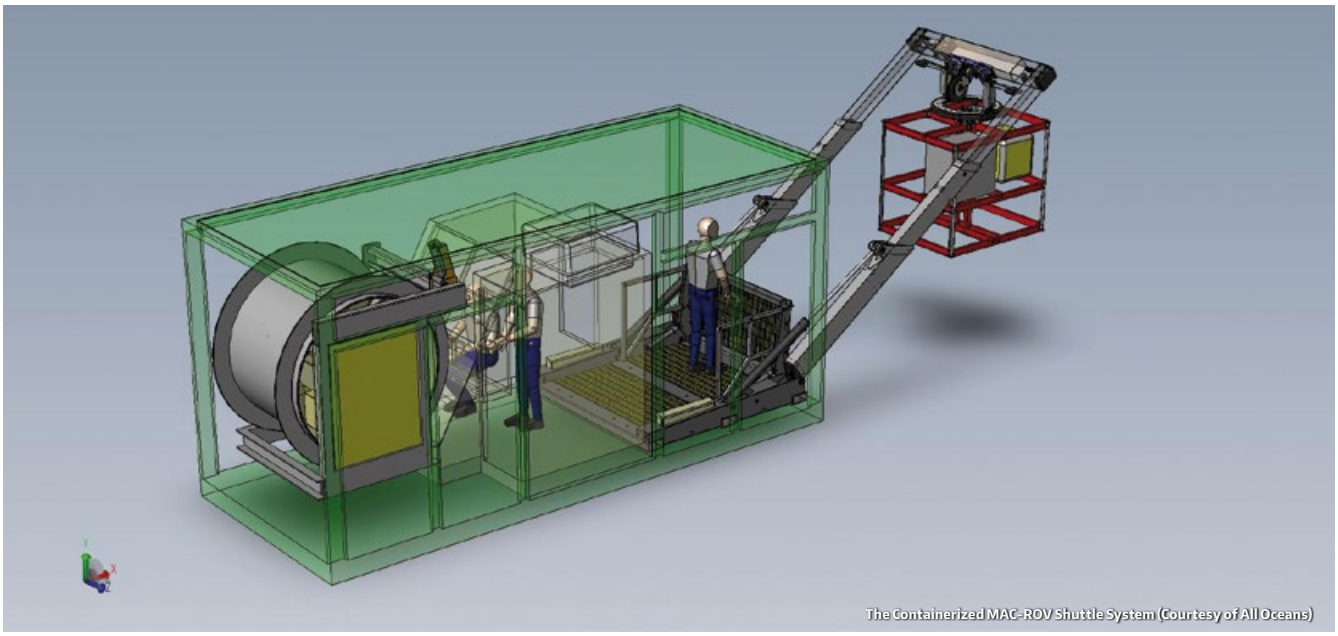
The "TV Studio Shuttle" Configuration (Courtesy of All Oceans)

radius flights about an imaginary point of rotation in different planes are possible. Add to this the coordination of the three different and independently controlled bodies (2× MAC-ROV, 1× Shuttle frame) with different arrangements of lighting and cameras and you have the ability to experiment and set scenes and run different shoots. This is what cinematography is all about. All these options and layers of control are achievable when the 6 degrees of freedom are available, with vehicle stabilization and relative motion sensing.

A "TV Studio Shuttle" would typically consist of two MAC-ROV Fly-out systems. The Shuttle, fitted with thrusters, cameras and lights forms the third controllable camera and light platform. Any need for significant amounts of flood lighting would be provisioned for on the Shuttle whilst the two MAC-ROVs would be the principle mobile cameras and spot lighters resulting in three independent flight controllable bodies underwater. This gives the option of alternating between using one ROV as an illuminator spotlight and the other ROV as a camera, with the two different angles giving a real cinematography approach. Being able to see one ROV with another can be used to add interest and scale to a shoot and the story as and when required.

Admittedly, as an alternative to the "shuttle" concept, one could put two ROVs into the water from separate locations on a vessel, but then the operators run the risk of tether entanglement as the tethers are tensioned. As soon as two cables touch, the laws of physics guarantee that they will twist. The loads don't even have to cross paths, it is enough for the cables to touch and they will be twisted together. Then the more they get pulled the more they twist as each

The LARS of the MAC-ROV Shuttle



The Containerized MAC-ROV Shuttle System (Courtesy of All Oceans)

cable has a helical winding on it. If this happens, the operator will hardly ever get their system back unless the tether is cut. On the other hand the MAC-ROV shuttle system provides a safe way to transport two ROVs underwater to any depth or location. Of course there is still the risk of tether entanglement, but because the cables are not tensioned those tethers can be untangled by flying out of that situation or the shuttle can be the recovered and the relatively short tether untangled on deck.

In comparison to the above mentioned "TV Studio Shuttle" configuration, a "Discovery Shuttle" may consist of one MAC-ROV fly-out system, wide area scanning sonar survey system, a manipulator sample and artefact retrieval system and possibly a small rock corer or marine biology sampler.

Finally, cinematography typically keeps the technology out of a regular shot, but in the underwater world the ROV and the supporting technology can add significant interest especially when it comes to documentaries where the technology and the challenge of the expedition itself can be a story in itself. This is only possible beyond diver depth if there are two ROV in the water.

Docked MAC-ROV Vehicle (Courtesy of All Oceans)

All dive adventures or even commercial operations carry risk, and salvage companies are a good example of this, and we are seeing more mobilisations taking a film production crew along. There will always be a story to tell about the dive and the risks but filming the story will typically guarantee some commercial return even if the mission doesn't work out as originally planned. Some stories on History Channel and Discovery Channel are good examples of this. The Shuttle concept opens up opportunities that have not previously existed.

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MARINE IMAGING TECHNOLOGIES REVEALS PIXEL

A CINEMA CLASS ROV FOR SUBSEA DOCUMENTARY AND ENTERTAINMENT UTILIZATION

Pixel, the First Product in Series of the Cinema Class ROVs, Enables DPs and Storytellers to Capture Cinema-Quality Footage beyond SCUBA Depths by Merging Top Cinema Technologies with Advanced Underwater Filming Techniques

Photo by Brett Seymour

Marine Imaging Technologies (MITech), a leader in developing state-of-the-art underwater optical imaging platforms, introduced Pixel, a Cinema Class ROV. Pixel is a multi-camera underwater filming and exploration platform that will facilitate deep water and coastal storytelling unlike ever before, enabling storytellers to record cinema quality images while minimizing the associated hazards and costs. Pixel, as well as other forthcoming ROVs in MITech's Cinema Class line, simultaneously hosts multiple cameras with live video and control feeds. From Ultra Hi Def (UHD) and large format stills to Stereoscopic and Virtual Reality, Pixel's versatility broadens the choices for aquatic storytellers.

"Telling stories about underwater is always a challenge, but once you enter deeper water where diving becomes less feasible, there simply were no options for true cinema class filming," says Evan Kovacs, an Emmy nominated cinematographer and founder of Marine Imaging Technologies. "To that end, the Pixel platform has been designed from the bottom up to accommodate not only the exciting cinema quality we've all become accustomed to, but also to lessen the burden on the filming budget. We're thrilled with Pixel and think it will be a game-changer in the industry."

Before Pixel, underwater storytellers managed the filming process using submersibles or ROVs with the capabilities to accommodate a moderate camera and lighting system, which in turn required extensive surface support. Pixel was conceived as UHD was becoming mainstream and is designed to fully utilize UHD cameras and subsequent cinematic advances. In addition to the multitude of camera options, Pixel is designed with a lighting system capable of over 100,000 lumens of articulated lighting and a precision thruster configuration to perform smooth cinematic movements. Pixel's controls, in the hands of pilots who have a real world understanding of camera moves and working in a deep water environment, will make for a unique directorial experience and enable exploration and cinema filming in a way that has never been possible from a vehicle of this compact size. For cameras operators, Pixel will be intuitively familiar, since the system was designed to incorporate the controls of industry standard remote lenses and camera control systems. Additionally, the MITech design team added portability to the list of requirements, designing Pixel to break down to fit into industry standard pelican cases, allowing for airline transport to locales where big containers are not possible or are cost prohibitive.

"As a veteran deep water cinematographer and storyteller, I have often lamented that we had to strap cameras to vehicles that had absolutely no aesthetic, nor hydrodynamic characteristics. Considering we are living in a time where multimedia has been absorbed into the foundation of our education and entertainment culture, we knew this needed to change," says Kovacs. "Our aim was to make Pixel move well in the water, have the best cameras and look like it actually was designed to be our literal eyes beneath the sea. We want Pixel to become an intimate part of the constantly evolving and changing dynamic of our underwater world."

Pixel and the Cinema Class ROV were created to provide storytellers with better tools. In her standard configuration, Pixel carries 8 cameras, all live streamed to the surface: four for the camera operator and four for the pilot. A Sony FS700 for HD and 4K video, a Sony Alpha 6500 for stills and a Blackmagic Design Micro 4K as down camera video have been used simultaneously. The housings and signal system were designed to be universal, allowing the change out of the cameras as needed. The cinema cameras are controlled by topside computers. Each camera video feed routes through a 4k router to a bank of monitors and recorders. The topside system also includes a Harris Neo GPS/Timecode unit. She has 100,000 lumens of dimmable LED lighting, controlled topside. She travels in two D containers but was designed to disassemble and pack in to pelican cases to travel to locations where sending D containers is not possible, nor preferable. Her team consists of a pilot and a tether tender.


Photo by Evan Kovacs


Photo by Brett Seymour

While some of the field tests were performed from a 24' vessel, the preferred minimum is a 30'+ vessel with at least 64 sq. feet of open deck space and a crane or davit. Pixel's field tests began in Buzzards Bay, USA, known for its currents and murky waters. Following that she deployed to the southern coast of Spain to participate in an archeological survey. This past year MITech partnered with the Wisconsin Historical Society to bring Pixel to Lake Michigan, USA. The expedition's successful goal was to capture 4K footage of the recently discovered SS Senator and her cargo of 1929 Nash automobiles. Pixel has also been used to capture 4K footage of other Lake Michigan wrecks and most recently, the spawning beds in Yellowstone Lake, USA. While the preferred topside vessel is 10m or more, Pixel and her support team have used vessels as small as 7.5m.

The look of Pixel was intentional so that, if desired, she could become a character in the story she is telling. Her movements are intended to be the smooth moving shots desired by cinematographers. She has a six thruster configuration to achieve smooth lateral and vertical movements and a 300m neutral tether.


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PUSHING THE BOUNDARIES OF SONAR TECHNOLOGY

Tritech has a long-standing reputation for breaking new ground in sonar imaging technology. In the 1990's the Company developed a sonar that was significantly smaller than comparable models available on the market. This pioneering sonar evolved to become the SeaKing DST, an imaging sonar that today still remains an industry leader and the sonar of choice for obstacle avoidance.

The Company's continued investment in research and development, resulted in the expansion of its range of mechanical sonars, and saw the subsequent launch of the Micron Sonar – the world's smallest mechanical imaging sonar – an achievement that still stands to the present day.

With a strong and expanding line in mechanical imaging, Tritech brought its focus firmly on to multibeam imaging technology with the launch of its first multibeam sonar, the Eclipse. Further development saw the evolvement of Tritech's renowned Gemini range of multibeam sonars. The Gemini 720is and 720ik's unparalleled performance and reliability, continues to expand the reach of Tritech products into new markets as well as increasing its footprint in an established industry. This, together with the exceptional performance of the units to meet long-range and near-field imaging requirements, has established the Gemini as 'the standard' for subsea imaging.

Tritech is committed to an ethos of delivering the same high standards of innovation, reliability, and performance in all its products as standard. It continues to work closely with its customers to engineer robust and reliable solutions to the challenges encountered in the subsea imaging environment; this means continually pushing the boundaries of what is possible. With this in mind Tritech's next innovation, due for release in February, will see the delivery of yet another world first in sonar technology by the Company, reinforcing its reputation as an innovator and market leader.

Gaps mounted on a side pool (Courtesy of iXblue)

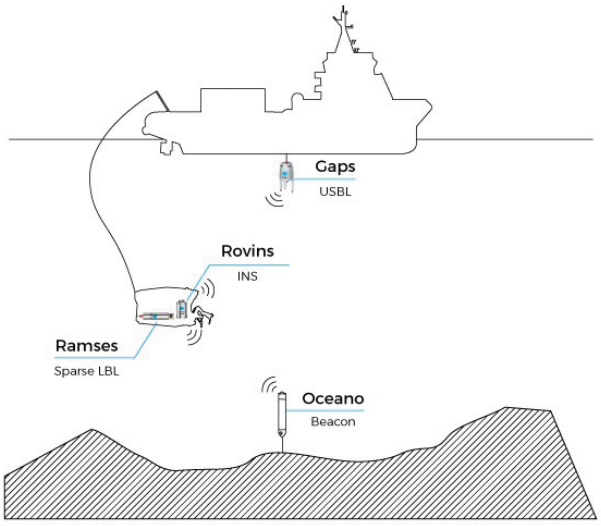
In recent years we have all got used to the Uber convenience of satellite navigation and expect to be able to find our way to our destination first time every time. If that statement doesn't apply to you then get a smart phone and fire up Google maps, you'll never go back to hanging out of the window to ask a stranger.

Underwater technology hasn't really kept pace. While satellite navigation has been revolutionising surface navigation, below the surface we have seen the rise of inertial navigation systems (INS). However, INS only improves existing systems, making them smoother and filtering out the obvious errors. It always needs that external input from a traditional ultra-short baseline (USBL) or long baseline (LBL) system.

"NAVIGATION ON THE CHEAP"

James Titcomb, Offshore Technical Manager, iXblue

SPARSE ARRAY, WHAT IT CAN AND CAN'T DO, AND WHY YOU MIGHT WANT TO USE IT



USBL

At first glance USBL seems to be the answer to all your underwater navigation needs. A device mounted on the bottom of the ship measures the range and bearing to a transponder on the vehicle. It is then possible to precisely calculate the position of the vehicle when combining those measurements with those from the ship's gyroscope, GPS and attitude sensors. In practice however, USBL is only accurate at a relatively short range and the signal is eventually lost as the vehicle gets further away from the vessel.

USBL also requires very careful calibration before it is ready for accurate tracking. The offset between the acoustic head and the ship's gyroscope and attitude sensors must be known and compensated for. A calibration that can take up to 12 to 18 hours. However, the recent introduction of pre-integrated motion compensation in USBL systems, and in particular in iXblue's Gaps USBL, have significantly reduced that timeframe and better systems can now be deployed and operated in a short period of time.

Another issue often encountered by users of USBL systems is their low performance in shallow water due to the relative narrowness of their acoustic coverage reach and the many echoes produced by the lack of depth. The use of iXblue's Gaps USBL system that distinguishes itself from other USBL systems by providing robust performance in very shallow water (10 m depth) can be the solution to this issue.

The sound speed profile must also be compensated for considering that the changing pressure, temperature, and salinity in the water all cause slight variations in the speed of sound which causes the acoustic signals used by the USBL system to curve. This aspect must thus be accounted for in the calculation of the vehicle position.

In a USBL system, the range to the transponder tends to be measured reliably and accurately, the main issue arising with acoustic interference that can come from many sources such as the machinery on the vessel and ROV. This noise also limits the maximum range of the USBL system.

A USBL system tracks the ROV by sending a sound pulse from the device on the ship to the transponder on the vehicle. This sound pulse has to be loud enough to be detected above the local noise when it arrives at the vehicle. Greater range will attenuate the signal, and a loud ROV may swamp it out altogether. To get around this problem it is possible to use a "responder mode". In that case an electronic pulse sent down the umbilical is used to trigger the transponder instead of an acoustic pulse sent through the water.

If great care is taken with a USBL system, the time is put into calibration and the sound velocity profile is correctly measured and entered, then accuracy of a few meters in 1000m of water are reasonable, depending on the environment and on propagation conditions. For many jobs this is sufficient, but many operations require more precise positioning. Traditionally when the highest precision is needed we have to deploy an LBL array.

LBL

LBL requires at least three beacons to be deployed on the seabed. A device on the vehicle is then able to measure the range to the deployed beacons. To be able to use this range information to position itself, the ROV must first know the position of each beacon. The position of at least two beacons must first be measured from the surface using a "Box In" procedure. Once this position is known, the beacons can interrogate each other to determine the distances between them. Knowing the range from each beacon to the other and knowing the position of two of the beacons, the position of all of those beacons can then be derived.

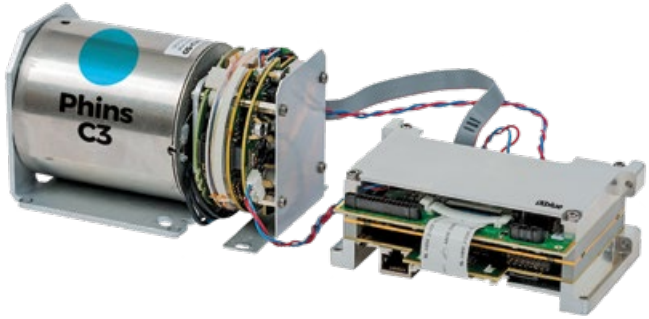
This process is known as mutual calibration and relies on there being enough beacons in range of each other to allow the calculations to proceed. For instance LBL tends to use many more beacons than just the three that are required for positioning. Typically a small local area will thus be covered by an array of 6 beacons while larger areas or routes will require many more. The process of deploying an LBL array and the extensive time required to perform a calibration is one of the main drawbacks of the system.

In order for a moving vehicle to calculate a position using LBL acoustics, it must simultaneously measure the range to at least three beacons. Because of this, LBL systems will typically interrogate all beacons within range whenever a position is required, sometimes as frequently as once per second. A recent study showed that on a typical field development the LBL system was interrogating ten or more beacons every second leading to excessive battery use in the beacons and necessitating frequent transponder maintenance.

INERTIAL NAVIGATION

At its most basic, inertial navigation is the process of measuring movement at such a high accuracy that if you know your starting point and you measure your motion well enough, you can calculate your end point. Of course, you can never measure the motion perfectly, and in fact there is no direct way to measure motion, only acceleration and rotation rate

are possible. These raw measurements then have to be mathematically processed to produce heading and speed. Inertial navigation systems come at various grades, ROVs mainly use high-grade systems. Leader on the inertial navigation systems market, iXblue's range of gyrocompasses and motion sensors offer unrivalled performance and reliability for all types of underwater vehicles, from small ROVs dedicated to underwater survey operations (Octans Series) to ROVs and AUVs needing high-grade INS for ultra-precise underwater positioning (Phins Compact Series and Rovins Series).



Phins Compact C3, ultra-compact INS dedicated to AUVs (Courtesy of iXblue)

The best INS systems used in the commercial market will have error rates measured in KM per hour. iXblue's best commercial unit, Phins, drifts at a rate of 0.6nMi per hour. Compare that to the top end military products iXblue offers which drifts at 1nMi in 72 hours.

INS drift has a cumulative error, accelerator bias leads to velocity errors, and these velocity errors build up over time. However the errors initially build very slowly, the error build-up accelerates over time, leading to the 0.6Nmi/h specification, but over a few seconds, there is very little error build-up and we find the INS is extremely accurate for short time periods.

In order to get the best navigation out of an INS, it is necessary to couple it with external aiding sensors. A Kalman filter (mathematical algorithm) is used to compare the external aiding data with the internal measurements and over time it will be able to identify the offsets and biases of the internal sensors and make the necessary adjustments. Interfacing a DVL to the INS can for instance reduce its drift rate from 0.6nMi in an hour to better than 1m for every 1000m travelled.

We previously discussed USBL and LBL systems. Now we can see that by feeding USBL data into an INS, the INS will also be able to use this data to correct its internal sensors. The INS position is thus bound by the USBL data. Typically the INS will improve on USBL aiding by a factor of three or more. So if we have a USBL system with a noise of around 10m on the data, we will end up with an INS position with an accuracy of 3m, less if we are using DVL. The USBL positions will be very noisy, jumping large distances from point to point each time the beacon is interrogated. In contrast, the INS position will be available hundreds of times a second and will not jump from point to point, but will slowly move following the average of the USBL positions.

Coupling an INS with a DVL and a USBL is thus an excellent solution for ROV navigation in deep water, as it gives relatively good accuracy and is quick to deploy and operate. However, as a ROV gets deeper into the ocean, increased accuracy might be needed.

Traditionally, when the accuracy delivered by a USBL aided INS is not enough, the default choice has been to deploy an LBL array. We have seen the drawbacks of traditional LBL, and an INS can fix some of these problems and in particular the low update rate. It can also improve on the noise level of LBL positioning, but if we are to fix the problems of extensive calibration time and excessive beacon maintainable (changing batteries) we need to move away from traditional LBL towards sparse LBL.

SPARSE LBL

The term sparse LBL refers to positioning with fewer beacons than are needed for a traditional LBL calculation. By aiding the INS with the range to a known beacon, we can be absolutely sure that the INS lies somewhere on a line represented by that range and we can therefore correct the INS error in the direction of the beacon. If we now gather a range from a beacon that is 90 degrees to the original beacon, we have fixed the INS position in the other access. By using only two LBL beacons we have positioned the INS to an accuracy of just a few centimetres. And of course it is quicker and cheaper to deploy an array consisting of just two beacons than it is to deploy a local array of six beacons. If we know the ROV will be moving around a local area it is even possible to aid the INS with only a single beacon and still active overall positioning accuracy of 50cm or so.

In a real life scenario, iXblue studies have shown that most operations can be conducted with around 50% of the beacons that a traditional LBL system would use. However, there are more benefits to using iXblue's Ramses acoustic synthetic baseline positioning system for sparse LBL positioning.

A traditional LBL system requires ranges to multiple beacons all at the same time in order to calculate a position fix. However the INS is able to make use of only one range in order to correct some of its internal errors. One must also keep in mind that over short periods of time the INS is extremely accurate. And so, rather than with an LBL system interrogating all local beacons every second, Ramses can interrogate beacons one at a time, and only periodically, typically only every 5 seconds, thus saving battery time for the beacons. For instance, in a scenario where there are 6 transponders in a local array, traditional LBL will interrogate each beacon every second leading to 6*60 (360) interrogations per minute. Meanwhile, the Ramses system will interrogate only three of those beacons with one beacon being interrogated every 5 seconds, leading to a total of 12 interrogations per minute. In a Ramses based system the beacons are thus being interrogated 30 times less than a beacon in a traditional LBL system. Extending the battery life of your LBL beacons by a factor of 30 has real significant impacts on the cost of operations, and all this is possible without compromising the overall accuracy of the positioning.

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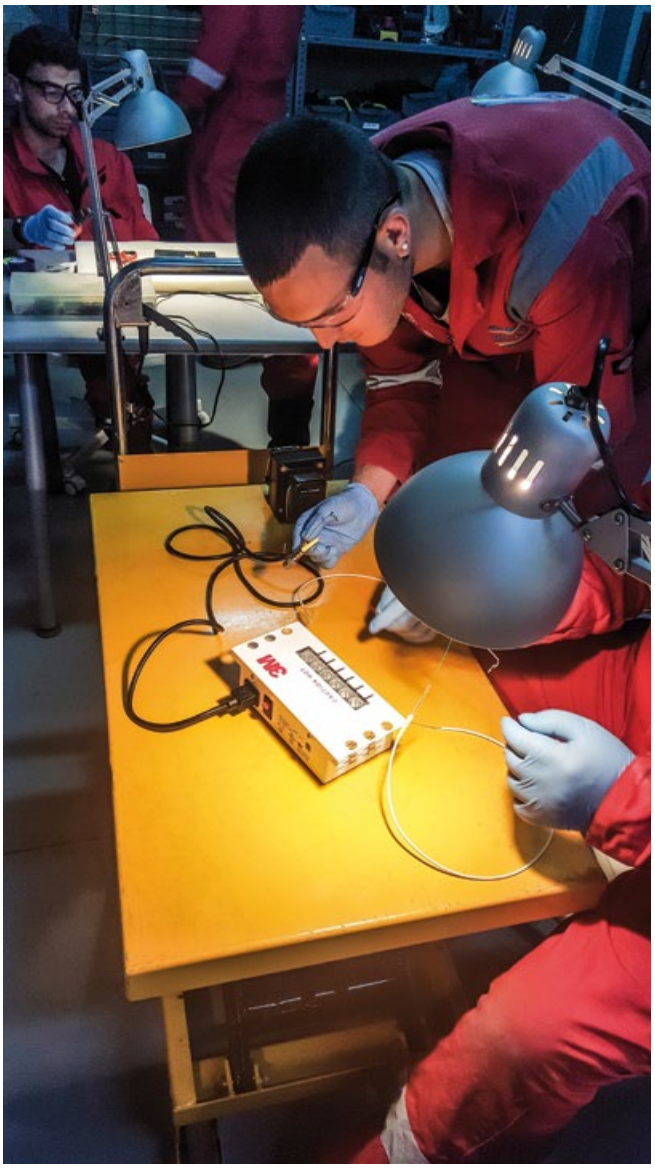
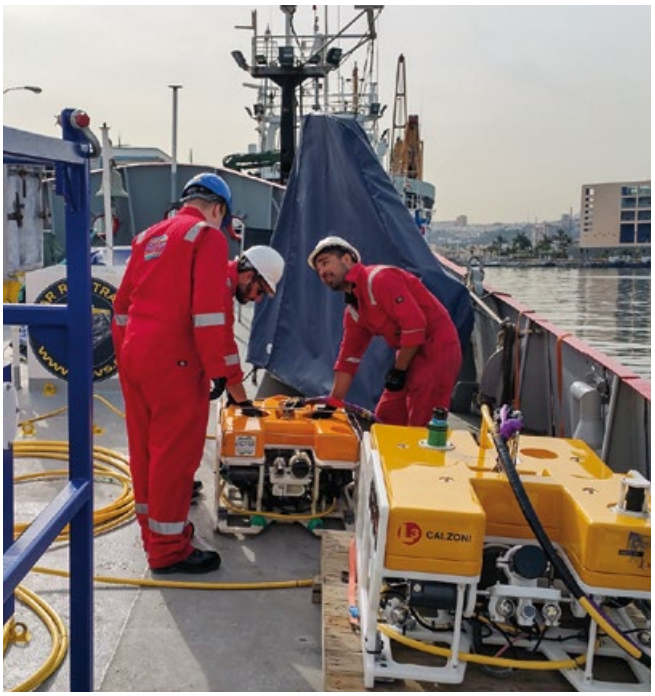
QSTAR ROV PILOT TRAINING CENTRE

HYDRAULICS & FIBRE OPTICS

By Richie Enzmann

In our regular ROV training column the next module was Hydraulics and Fibre Optics. Although many new ROVs are becoming all electrical these days, hydraulics systems are still needed for tooling applications when the extraction of a significant amount of force is required. For that reason, it's important to learn about this occurrence.





Equally important is the fibre optics communications; operators are more frequently enhancing their ROVs with additional sensors and high quality imaging equipment. In our information-hungry society we want to have access to most of this information in real time. In order to provide this real time access it's necessary to increase the bandwidth, and fibre optic communications allows us to greatly increase data transmission.

This time the main course instructor was Elliott Ramos Madrid. He explained the basics of hydraulics to the participants. Most hydraulic systems have a generator connected to a pump to create pressure within the system that will be used to power a load. With ROVs this could be rotating thrusters or luffing cylinders in launch and recovery systems. This pressure is then transported via various tubes, hoses, and connection devices, and safety devices. We had the chance to try out all of this theory in the lab, where we had to create a functioning system with a motor and a cylinder load.

On a separate day the focus was on Fibre Optics communication. Again, the basics were explained and then the trainees had the chance to make up their own fibre optic connectors using specialised tools. Then we tested the connections and data transmission.

Again, this cohort had different trainees participating from different countries, including England, Italy, Romania, and – of course – Spain. Chris Sands, a Chief Mechanic on a seismic vessel from England started the course to increase his range of experience, as many ROV techs require a multidisciplinary approach. He chose the three week training course because he already had hydraulic and electrical experience, and he wanted to learn more about ROV operations. QSTAR also offered him the flexibility to fit the training into his break time onshore.

Alin Ghilezan, an Electronics Engineer working for an Oil Refinery in Romania. His company recently bought an ROV, and Alin was sent to the course to learn more about the responsibilities of an ROV pilot. Since he has a passion for robotics and automation, he applied for QSTAR to combine the theoretical knowledge with practical experience working in the field and on a vessel.

"During my first week on the course I managed to get some new information while I practised and consolidated the knowledge I already had.", says Alin. "The instructor is well prepared and he gives me time to understand the most difficult parts of the course. He also answers all of our questions any time we need more explanation on a particular subject.".

Dimitris Konstantis was one of the more experienced trainees on the course. The 32 year old Greek had seven years of experience already in jetting/trenching operations with Assodivers. Currently he is a student in Integrated Coastal Management at the Aegean University, and is spending six months at the Las Palmas University as part of the Erasmus

student exchange programme. He chose QSTAR because it is an opportunity for him to expand his knowledge in electronics and to become more familiar with the IMCA standards and procedures in the ROV industry.

"The most interesting part of the course so far is the theory and the practical of electronics." Dimitris says. "The other parts of the course are familiar to me, so far, due to my experience. Elliot is really helpful and enthusiastic and able to provide explanations to any query."

Jordi Gil Guardia from Spain is a commercial diver working in the aquaculture sector. He chose QSTAR because it's the only training centre in Spain that provides ROV training. The premium course will enable him to understand electronics, hydraulics and ROV maintenance. He can see ROVs performing some of the tasks that were historically done by divers; hence his decision to move into the world of underwater robotics.

Finally, Gianluca Belardinelli aided the group both in the workshop and on the vessel. He's spent his time at QSTAR within the framework of the company's internships scheme where he had the chance to work with the professionals side by side in further developing his skills before being offered a position at the company as an ROV Pilot and Assistant Instructor. "At this moment we are working on a project that involves the laying of a cable for an offshore wind turbine. It is a job with a lot of responsibility, especially when we work at night without any visual reference and we need work with instrumentation. We use an Italian ROV, the Ageotec Perseo GTV, DGPS Heading system, Hypack Hydrographic Survey software, a BluePrint Seatrac USBL system for subsea positioning and other instruments such as the Tritech sonar & sensors. I am happy to be part of this team! We are a tight-knit team and we work hard to carry out our work best in training and in work!", Gianluca tells me.

"During Gianluca's stay in our Subsea company division he had the opportunity to be part of the ROV team to test an USBL SeaTrac System (X150 & X110 models) manufactured by BluePrint Subsea. The X110 beacon has a depth rating of 2,000m so it's very suitable for our ROV fleet. Since 2006, BluePrint have been designing and manufacturing products for the offshore, subsea and commercial diving markets, aiming to bring the latest advances in technology at an affordable cost without comprising on quality or function.

"In the April 2018 issue of the ROV Planet Magazine, the new Testing Technology Section, will include a full review about the test results of the SeaTrac USBL system where we can update the readers about the accuracy of the acoustic tracking it provides.", explained Victor Javier Sepúlveda López, the Managing Director of QSTAR.

Later on in the week the team had a trip to the training school's 25m long vessel, the Atlantic Explorer to practise more ROV piloting using the EPRONS ROV Builder. This mini-ROV is a very stable and cost effective work-horse. We inspected the hull of the Atlantic Explorer paying special attention to the vessel thruster and the cooling water suction point to make sure they were all free of marine growth. Then we verified that the anodes fixed onto the hull were not depleted and were still adequate for cathodic protection.

To further develop our piloting skills, we also added some simulator time, practising more complex scenarios. This involved acting as pilots and co-pilots working on submarine rescue, BOP emergency closure, and suction pile installation missions. These missions give the students a better understanding of the subsea engineering environment that they could encounter in the future.

The next module will be Offshore Operations – probably the most anticipated part of the course – where we will get the chance to pilot the ROVs in the waters surrounding the Canary Islands.

ROV PLANET

PLOCAN
Marine Test Site

The PLOCAN offshore test site area is 23 km², located 3 nautical miles from the PLOCAN Land Base and also quite near to the major harbor of Gran Canaria Island (Las Palmas Port). The area offers progressive depths from shore up to 600 m (deeper upon request) dedicated to study the behaviour and efficiency of different types of maritime devices and technologies and contributing to speed up the process of their introduction into the market.

The marine area of PLOCAN test site was comprehensively studied with a view of offering an optimal space in terms of logistics, supported infrastructures and grid connection. In addition, the area has excellent environmental conditions facilitating at least 9 months of operational window and optimal wind and wave energy resources for testing/demonstration operations, which range from 300-400 W/m² for wind power density and from 4 to 8 Kw/m of wave power.

Platform

Technical zone (400 m²).
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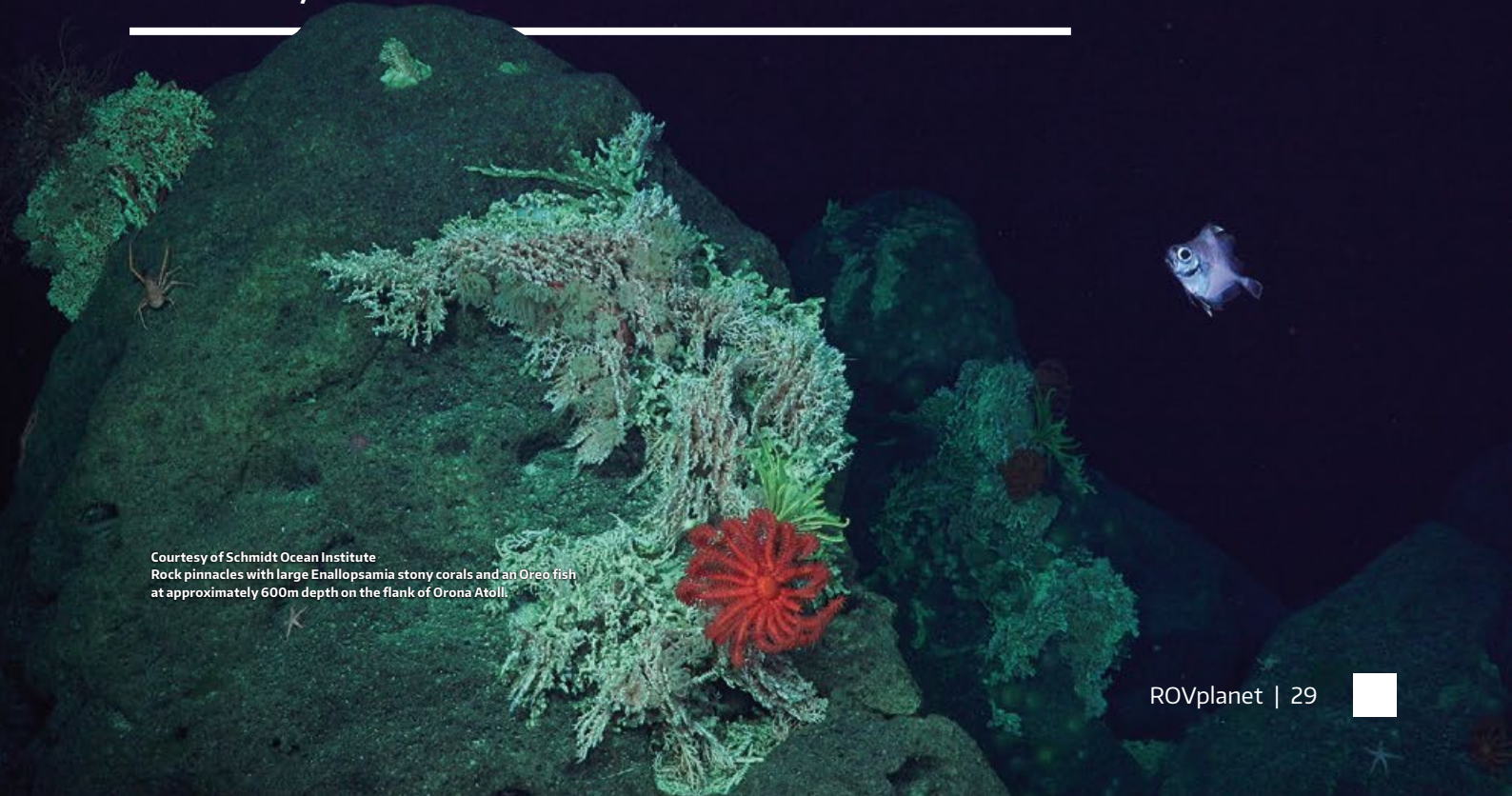
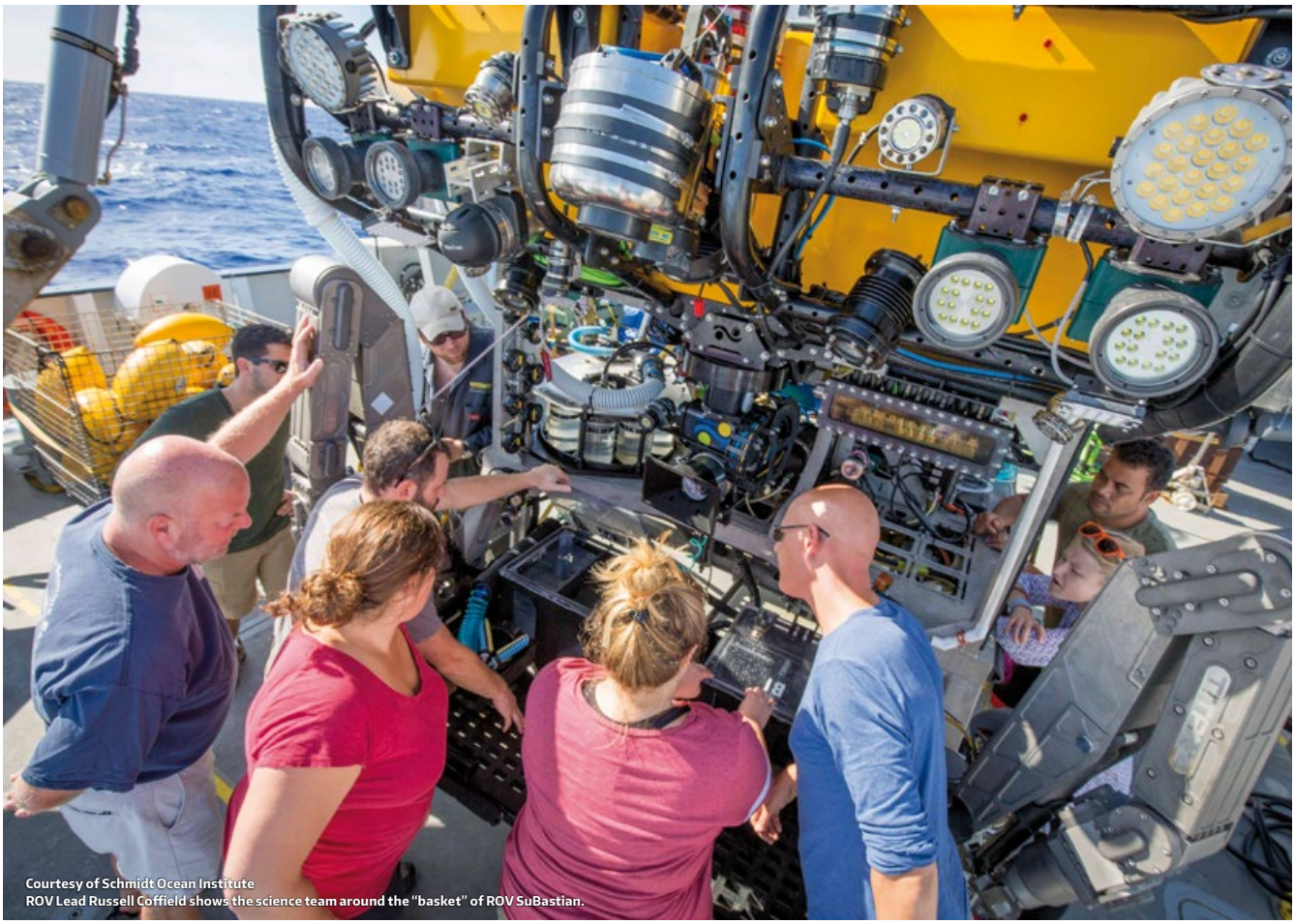
Scientists return on Schmidt Ocean Institute's research vessel Falkor after conducting underwater robotic dives in never before visited waters in the Phoenix Islands Protected Area (PIPA)

APIA, SAMOA – Seventeen underwater robotic dives have been made using ROV SuBastian, completing the first expedition of the islands and eastern seamounts of the Phoenix Islands Protected Area (PIPA) in the nation of Kiribati. This follows an initial exploration of the western seamounts by the NOAA Ship *Okeanos Explorer.* "This journey was in the tradition of the grand research expeditions of the past," said Chief Scientist Dr. Erik Cordes from Temple University. "We traveled nearly 3,000 miles across the Pacific Ocean and explored a part of the world that has remained entirely hidden from view until now."



Courtesy of Schmidt Ocean Institute
Rock pinnacles with large Enallopsamia stony corals and an Oreo fish at approximately 600m depth on the flank of Orona Atoll.



Courtesy of Schmidt Ocean Institute
ROV Lead Russell Coffield shows the science team around the "basket" of ROV SuBastian.

The expedition on board of R/V *Falkor* has made a major contribution to the field of marine science, defining the habitat zones of a seamount from the deep sea to the surface for the first time, and discovering at least two new species of coral and crab. Researchers collected the deep sea specimens by using a new soft robotics technology, "squishy fingers", for adaptive sampling developed by the Wyss Institute and Harvard University and further refined by 3D printing on board while at sea.

All the robotic dives were live-streamed in high definition on Schmidt Ocean Institute's YouTube and Facebook page, attracting over 100,000 views. The diving and camera technology on ROV SuBastian allowed the scientists to make new observations of octopus behaviour; and capture one of the deepest records of mantis shrimp observed. Videos will be held in perpetuity showcasing breath-taking footage of deep coral reefs, dumbo octopuses, and six-gill sharks.

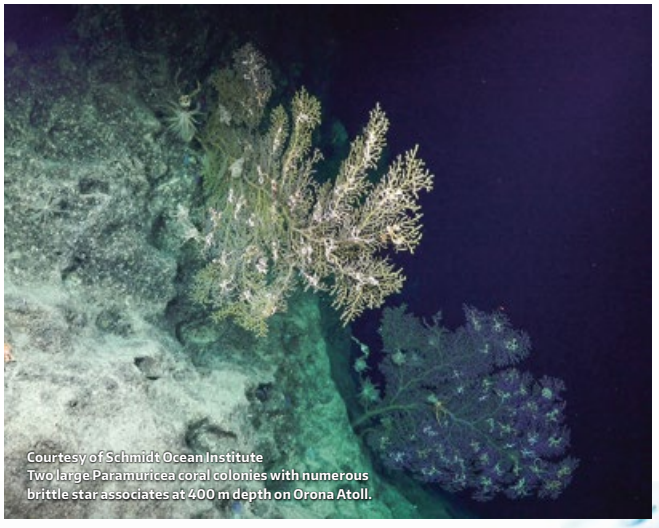
"This expedition will help to inform conservation and management goals for the region," said one of the expedition leads Dr. Randi Rotjan, from Boston University. "As deep-sea mining continues to gain traction in the region, this information will help to inform responsible management of deep sea communities."

Courtesy of Schmidt Ocean Institute | Image of science team. The science party in the laboratory on board the R/V Falkor with all of the specimens collected during one of the deep-sea ROV dives.
From left to right: Alexis Weinnig, Abigail Keller, Luke McCartin, Anna Gauthier, Tim Shank, Erik Cordes, Daniel Vogt, Aranteiti Tekiau, Randi Rotjan.

Courtesy of Schmidt Ocean Institute
Image of dumbo octopus: A large "dumbo" cirrate octopus on the steep cliffs of Tarina Seamount at approximately 1200m depth.

Courtesy of Schmidt Ocean Institute

The Phoenix Islands Protected Area (PIPA) was the first large marine protected area to include substantial deep water habitat in its boundaries. As of Jan 1, 2015, PIPA became fully closed to all extractive and commercial activities (with the exception of a small sustainable use zone around Kanton), generating an ideal space to ask questions about ecological baselines and species distribution. "Despite our intensive exploration of eight previously unmapped seamounts and island atolls, from 2,400 m, to a shallow 100 m, there was very little evidence of human presence", said Dr. Tim Shank of the Woods Hole Oceanographic Institution and one of the Principal Investigators of the expedition. "We encountered a high biodiversity in these areas and the recent establishment of the protected area can ensure we have important model deep-sea systems for future research."



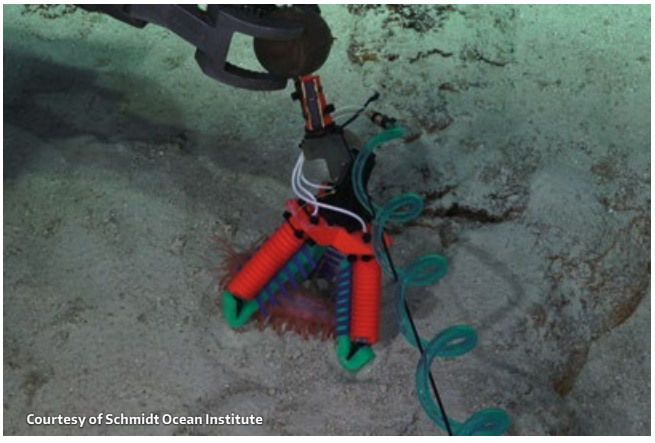
Courtesy of Schmidt Ocean Institute
Two large Paramuricea coral colonies with numerous brittle star associates at 400 m depth on Orona Atoll.

SQUISHY FINGERS:
AN ALTERNATIVE APPROACH IN ROBOTIC ARM MANIPULATION

On-board the Schmidt Ocean Institute's Phoenix Islands expedition was Daniel Vogt, a research scientist from the Wyss Institute at Harvard, who's research laboratory has come up with a clever solution for an alternative robotic arm manipulation, named "Squishy Fingers".

There are many delicate items (and creatures) that are difficult to handle with the standard hard bodied robotic arm configuration when it comes to the field of marine biology and underwater archaeology. The solution in these cases would be the use of a bio inspired octopus-like claw, made out of soft and composite materials, to surround and grasp the delicate objects without breaking them. The Squishy Fingers can be used as an extension to the existing manipulators similar to an ROV Tool to do a specific task.

"My main area of research is soft robotics, which is a relatively new field in robotics that really pushes the boundaries compared to what robots could do before, and in this case grasping objects that are delicate and deformable. A group in my lab has pioneered the basis of these gripers a few years ago using soft robotics actuators that they have developed and then eventually tested in the Red Sea. This formed the basis of using these 3D printed manipulators for deep sea sampling. Many improvements have been done since and we made the setup easy to install onto any ROV," explained Daniel.


Courtesy of Schmidt Ocean Institute

Courtesy of Schmidt Ocean Institute

"My role was to help the biologist with sample identification and to modify the design of the Squishy Fingers using 3D printers and rapid prototyping techniques, as we were in the middle of the ocean, based on the feedback from the biologists and the ROV Pilots on board the vessel."

"The manipulator tool is located at the front of the ROV and can be picked up from the tray by an existing robot manipulator arm. Then we have a control bottle with all the electronics and that communicates via a serial link to the surface where we can send commands from the laptop to open and close the manipulator. There is also a manifold to address several manipulators at the same time, a pump that works at depth, and an accumulator to store energy in order to fill the actuators. It is a system on its own and can be dispatched with an ROV and put onto several places to keep the vehicle balanced. In the case of SuBastian we had the whole setup in the back for balancing purposes. But this setup has also been used this year on the Nautilus and in that case they split up the system and placed it in different parts of the ROV. In these designs we didn't have to modify anything on the existing Schilling Robotics manipulator," concluded Daniel about the operating principle of the Squishy Fingers.

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GLENAIR INTERCONNECT TECHNOLOGY FOR ROVS AND AUVS

Leighton Mauro, Business Development Manager, Glenair, Inc. | Brad Fisher, Business Development Manager, Glenair, Inc.

ROVs are the backbone of all deepwater offshore operations: From installing assets and bringing wells online, to the complex business of decommissioning end-of life fields. ROV equipment sets are pressure resistant, making it possible for the vehicle to function and operate in harsh and remote depths. In the demanding deep-water operations environment, electrical engineers specifying interconnect technology must consider extremes in temperature, pressure, and corrosion when choosing appropriate cables and connector sets to bring power and data to and from equipment and tools. Connectors must be evaluated for mating consistency, termination and over-molding or oil filled hose durability by evaluating working conditions including cathodic delamination, corrosion due to dissimilar metals, and mechanical stress due to cable routing and wave action.

Pressure resistant connectors are required on all ROVs for electrical and optical circuits interconnecting payload components as well as for umbilical connectivity topside. 10,000 psi is the current industry standard for ROV connectors. Connectors typically employ front-end sealing technology or "open-face rating" which protects the electronics in the event of water intrusion into the connector due to unforeseen events underwater. Back-end sealing technology protects the termination zone for both cable and contact, and is often a weak point in connector and cable sealing. Various other techniques and materials are available for front-end and back-end cable sealing in subsea interconnects including: glass-to-metal, welding/brazing, metal-to-metal seals, over-molding, tapered threads, potting/adhesives/sealants, and O-rings.

O-rings are the unsung hero of sealing, and when properly applied can yield very reliable, high pressure sealing results. O-rings are small, cheap, suitable for high-mating cycle applications, easy to inspect, easily serviced, cheap to replace and, as mentioned, extremely effective when proper attention is applied to engineering best-practices. These practices include proper O-ring selection, which means the correct size and durometer (hardness). An O-ring that is too soft will extrude into the gaps when exposed to excessive pressure and will ultimately fail. However, an O-ring with a higher durometer will be difficult to mate unless the O-ring grooves and sealing surfaces have been carefully engineered.

Next to mechanical design, the proper application of materials science has the greatest impact on high-pressure sealing. Metallic and non-metallic materials must be evaluated for temperature extremes, fluid compatibility, abrasion resistance, gas decompression, and conductivity. Shore hardness is a particularly critical material selection criterion in high-pressure sealing applications as it directly impacts material performance under pressure. Extrusion gaps in the designed for clearance between metal sub-assemblies, for example, can be problematic for O-rings with Shore hardness ratings under 90. Many legacy subsea connector series were originally designed for shallower, lower pressure applications with shorter deployments. But today's requirements for 10,000 psi performance, or greater, and deployments measured in weeks, not hours, call for both better mechanical design and harder, 90 Shore-rated seals.

Many subsea applications utilize electrical and optical Pressure Balanced Oil Filled (PBOF) cables. PBOF cables use a compensating fluid-filled elastomeric tube as a conduit for the electrical and fiber optic lines. The elastomeric conduit allows the ocean pressure to transfer to the compensating fluid, equalizing the pressure differential. PBOF technology has been widely utilized in ROV design, ocean science exploration, drilling systems, production control systems, towed sonar arrays, and most importantly, for the interconnection of subsea floor structures and equipment.

Glenair has been manufacturing connector and cable assemblies since 1956 for some of the harshest environments from outer space to inner space. In recent years the Company has experienced unprecedented activity in the subsea market with the development of the SeaKing and Super G55 connector series. Not surprisingly, the ROV and AUV industries have been key players in this growth. Subsea connectors are inseparably linked with the operability and functionality of all ROVs and AUVs. Both connector series have been vigorously tested before rating them to 10,000 PSI in both mated and open face conditions, with a significant safety margins. Modern ROV and AUV operators demand high reliability components on their vehicles and these interconnect systems were designed to meet those expectations. Additionally, as a privately held company, Glenair prides itself on being completely vertically integrated and is able to maintain huge inventories to support their Customers' demands.

SEAKING

The SeaKing is a high density, glass sealed connector that utilizes dual O-rings and redundant sealing as standard. It is a 21st century connector that has been designed based on the best industry practices with many creative and unique advancements which address known limitations of existing designs. The SeaKing was designed with an eye toward modularity and flexibility which eliminates the need for special configurations for different applications.


The SeaKing Connectors (Courtesy of Glenair)

The indexable flange is a Glenair original design which allows the Flange Connector Receptacle (FCR) to be rotated and locked into place in virtually any position which eliminates the need for custom clocking of the Cable Connector Plug (CCP). Connectors can be positioned on the fly so there is no need for the user to carry a large inventory of spares with different clocking. Additionally, it is very easy to accommodate any special bolt pattern.

The CCP has many unique features as well. One of which is the threaded accessory porch. This innovative feature allows for a variety of attachments, including PBOF backshells, a stress core attachment which allows up to 500 lbs. of pull, an Anti-Cathodic Delamination feature, and backshells to accommodate fiber management. The engaging nut, with its wrench flats and aggressive knurling, makes de-mating after long deployments easy without the need to pull on the cable.

Hose barb fittings for PBOF cable assemblies are the perennial weak link in subsea oil & gas applications. Kinked and twisted hoses, leaky fittings, corroded hose clamps, and general poor performance characterize most existing solutions. The Glenair ferrule fitting and PBOF swivel hose attachment for SeaKing connectors solve these problems and more. Designed from the sea floor up to perform flawlessly and reliably, this revolutionary attachment puts an end to the long list of field maintenance problems associated with oil-filled cable applications and the smooth sweep design on the right angle adaptor prevents unnecessary wear and tear on conductors. In the event of a flooded hose, boot seals protect the conductors so that they system will continue to operate.

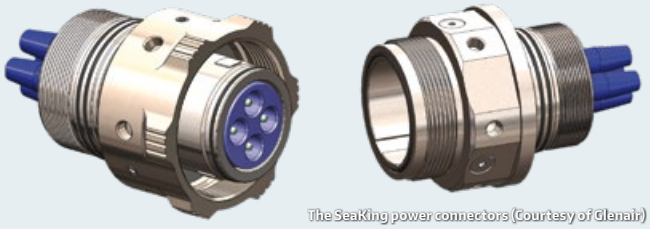
SEAKING FIBER OPTIC

The SeaKing Fiber Optic connector offers the same 10,000 psi rating in both Open Face and Mated conditions. They are offered in a variety of shell sizes and configurations, and can be terminated with molded cable or PBOF. When used as a PBOF, Glenair uses the same seals to the individual conductors so that the connector will continue to operate in the event of a catastrophic hose flood. As a vertically integrated company, Glenair performs all fiber termination and manufacturing in-house.

The SeaKing fiber optic connectors (Courtesy of Glenair)

SEAKING POWER

The SeaKing Power connector is currently offered in a 4 pin configuration(with other configurations upon request), which is designed for operation at 5kV. This connector too, has incorporated many valuable features in the standard SeaKing. The connector includes API O-ring test ports which allow the user to certify the integrity of the dual O-rings. The interchangeable inserts makes it easy to swap genders without having to use different shells, and the aft loaded inserts are secured with a threaded retaining ring to accommodate high pressure in both directions. A detached flange allows the bulkhead to be mounted in a position to reduce stress on the cable and ease of clocking. Additionally, the SeaKing Power connector incorporates an accessory porch very similar to the standard SeaKing which facilitates over-molding, PBOF backshells or other termination accessories.



The SeaKing power connectors (Courtesy of Glenair)

SUPER G55

This family of dry-mate underwater connectors is the latest generation of the popular, industry-standard marine connectors used on countless ROVs, underwater cameras, diver communications, lights, pan and tilts, and various other subsea applications. By addressing the strengths and weaknesses of previous generations, the Super G55 provides a highly reliable connector.

Alignment is much easier when connector face is visible. (Courtesy of Glenair)

The Super G55 is manufactured from 316L Stainless Steel with insert molded contact assemblies designed for pressure-sealed applications up to 10,000 psi in both mated and unmated conditions. Inter-mateable and inter-mountable with other "5500" series connectors, the Glenair solution introduces a long list of product innovations designed to improve performance and durability.

The CCP was designed to be used in either over-molded or PBOF configurations. There is no need to special order a connector for specific applications. When used in the PBOF configuration the PBOF backshell is held in place with 5 set screws which allow full 360° movement when positioning the hose. Three view ports on the engaging nut allow full mating inspection from almost any direction. While the shorter, fully retractable engaging nut makes it easier to line up the mating halves. And finally, the gold plated solder cups extend beyond the connector body for ease of soldering and an extender piece protects the solder joints when molding.

The PBOF versions, utilize easy-to-assemble threaded fittings which deliver superior sealing performance while reducing installation time. These are stocked in the Glendale, CA and in the Mansfield England facilities.

The FCR is available upon request with Glenair's Indexable flange for ease of keying right angle connectors to eliminate strain on the cable.

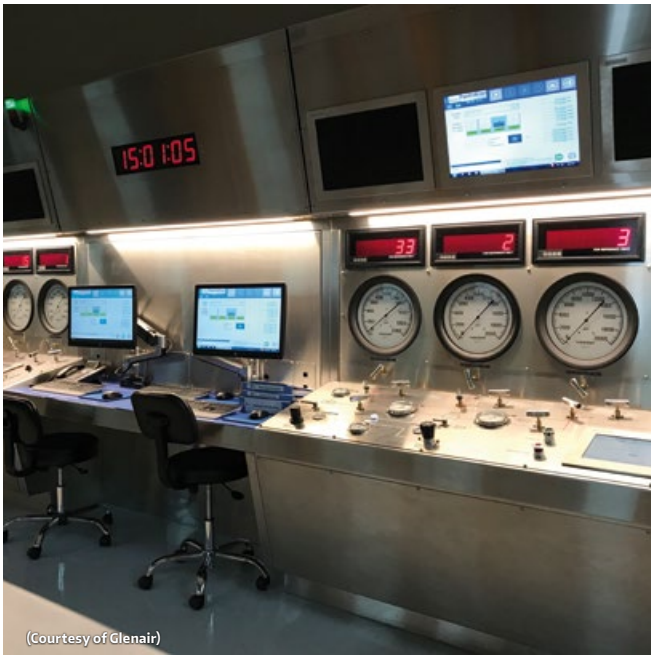
SUPERG HIGH SPEED ETHERNET

The Super G55 Ethernet option is available in the 1508, 2013 and 2021 contact configurations and provides high speed (Up to 1GB) and power (600Volts) in a full subsea environment (10,000 psi). Properly terminated connectors offer 1G Ethernet on cable lengths up to 200ft. Gigabit speed data transfer up to a distance that of 75 meters when properly terminated and appropriate cable is used.

(Courtesy of Glenair)

ACTIVE COMPONENTS AND PHOTONICS

Glenair harsh-environment fiber optic connectors and board-level transceiver technologies are designed for harsh sea, land, air and space environments and will operate reliably over very wide temperature ranges and high shock and vibration conditions. These proven technologies have been optimized to minimize size, weight and power and offer electrical-to-fiber conversion for Ethernet, video, signal aggregation and high-speed digital signals. The core of deepwater data transmission is achieved by fiber optics and is especially true with regards to Work Class ROVs that must perform in subsea fields at extreme depths.



(Courtesy of Glenair)

PRESSURE LAB AND TESTING FACILITIES

The Glenair marine/subsea technology team has the ability to design, produce, validate, and test its complete range of subsea interconnect technologies using 100% in-house resources. Glenair's hydrostatic pressure lab is a dual-mode pressure test facility equipped with both large and small form factor pressure vessels for testing complete cable assemblies, mated cable connectors, and even customer subassemblies. In addition, a small pressure vessel cell provides qualification and validation testing on discrete connector inserts. Both the large pressure vessel and small pressure vessel systems can validate and test up to 16,500 psi. Glenair's knowledgeable and trained subsea specialists perform both in-house product qualification testing, as well as customer subassemblies.

The modular consoles in the control room provide for up to 8 pressure circuits, operating in Manual or Automated mode. Monitors display test profiles, data acquisition and more. The system is network connected for access to profiles and distribution of test reports. The lab was designed for future expansion with additional pressure vessel and test equipment.


(Courtesy of Glenair)

CONCLUSION

Underwater connectors have come a long way in support of the subsea industry, addressing technological challenges with innovation, and the potential of an ever-expanding future. As a result, both the SeaKing and Super G55 Series connectors incorporate numerous modern design improvements that improve service life, safety, reliability and ease-of-assembly.

Both connector series take advantage of reliability and test standard disciplines developed by Glenair over the past 60 years in mission-critical applications. Glenair's SeaKing Connectors, for example, are 100% inspected and tested in the state-of-the-art hydrostatic test lab via a formalized qualification test plan. Glenair has addressed many industry challenges with these connector series and has the flexibility to tackle the future evolution of the subsea industry.

ROVTECH SOLUTIONS DESIGNS BENDER RCM TECHNOLOGY INTO ITS UNDERWATER VEHICLES

Remotely Operated Vehicles (ROV) designed by Rovtech Solutions are enabled with Bender's Residual Current Monitor [RCM] for advanced warning of potentially damaging water ingress.

The Rovtech Nano Seaker ROV has been designed to work in arduous environments including highly radioactive storage 'ponds' on nuclear sites. They are also commissioned for use in lakes and reservoirs to help with underwater search tasks and surveying of underwater structures and containment tanks. Weighing in at just 15 kilograms Nano Seeker is primarily designed as a camera platform giving a live feed back to the operator but it can also be equipped with a manipulator claw, and with sonar to enhance its underwater search capabilities.

Bender Linetraxx® RCM420 technology monitors and notifies if there is water ingress into the umbilical control tether or the ROV unit itself. The early warning is vital to ensure that developing electrical faults are identified so the vehicle can be recovered under power before critical failure.

Technical Manager Barry Vernon explains:
"Our ROVs operate in a range of hostile environments and the Bender equipment monitors the status of the electronics which power and control the units. It prevents a simple

Courtesy of Rovtech Solutions

leak developing into something potentially more serious, or presenting a safety risk to operators. Of course, the protection of the asset is vital, and to have continuous monitoring of the ROV allows optimum operational time which end users demand and expect."

Rovtech Solutions also aims to include Bender Linetraxx® RCM technology in the next generation of underwater vehicles being designed for the larger Adaptable Seaker ROVs which have seen decades of service on the Sellafield site.

Courtesy of Rovtech Solutions

Bender works with a range of original equipment manufacturers in subsea and offshore oil and gas sectors to protect personnel, systems and production. This is one example of how Bender technology safeguards costly equipment damage and cancellation of often highly expensive operations in the field.

Bender UK Industrial Business Manager
Phil Robinson commented:
"We are delighted to work with companies like Rovtech Solutions. They appreciate the capability of our technology and how it protects not only their assets but their reputation as one of the leading ROV companies in Europe. Working in this manner plays strength to our innovative approach to product design which is then complemented by Bender UK's excellent applications engineering.

Bender's range of electrical safety and intelligent monitoring and measurement systems are designed to deliver monitor and protect assets which work in some of the harshest operating conditions understand the critical importance of plant availability and resilience, and we welcome opportunities to work with OEMs to deliver the tailored solutions that safeguard their equipment. Bender technology is used in a number of ROV applications.

Zetechtics Celebrates its 25th Anniversary

Jupiter Type 1 (1998)

- First control system supplied 20 years ago
- Still fully supported

Jupiter Lite (2000)

- Compact & low-cost version of Jupiter control system
- Queen's Award for Enterprise: Innovation 2003

Jupiter Plus (2001)

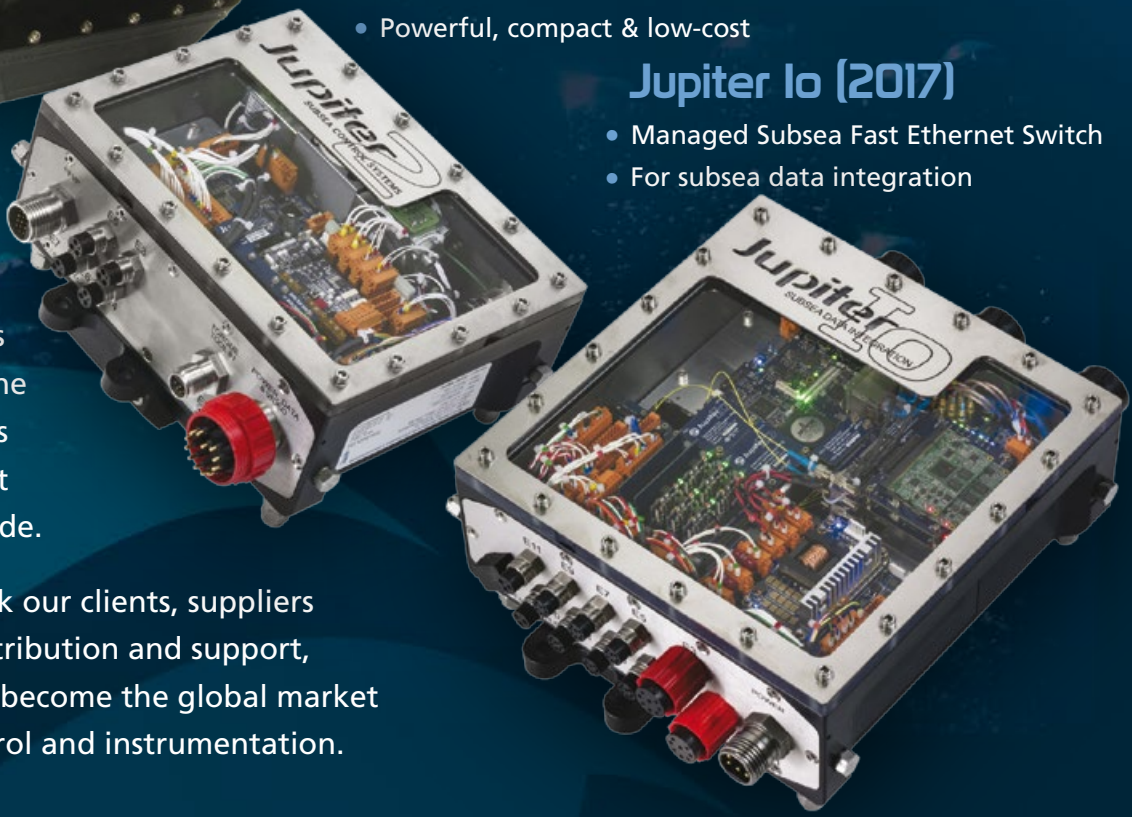
- Engineering update to Type 1 systems
- Many systems remain in operation today

Jupiter 2 (2009)

- Built on success of Jupiter with advanced functionality
- Upgraded with 5th generation J2E features
- Powerful, compact & low-cost

Jupiter Io (2017)

- Managed Subsea Fast Ethernet Switch
- For subsea data integration



For 25 years, Zetechtics continually provided the best technical solutions to work in the harshest environments worldwide.

We would like to thank our clients, suppliers and staff for their contribution and support, enabling Zetechtics to become the global market leader for subsea control and instrumentation.

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The Green Edge Project uses an ROV to study the Arctic marine ecosystem. (Courtesy of Lisa Matthes/Green Edge project)

ARCTIC EXPLORATION DEFINED:

ANY ROV CONTROLLED VIA A TETHER IS CONSTRAINED

Robert L. Wernli Sr., First Centurion Enterprises

ROV Planet is an excellent state-of-the-art magazine that addresses all aspects of ROV technology and developments. But our Planet includes more than the oceans and lakes where our ships can transit and drop in an ROV to full ocean depths for work, research or defense. So, where can't the ships go?—under the Arctic, or Antarctic, ice. Yes, ice breakers can get into some of the remote areas and make access for ships to launch an ROV, but that is about as effective as a fisherman in a dingy trying to feed a village with a single fishing pole and lure. That is not the way to try and understand the benthic and pelagic aspects of the vast and unexplored Arctic environment.

We can launch ROVs from ships along the sides of the Arctic ice and reach under, but again, that's not going to be too effective unless we have an 1,100 km tether. So, what is the solution? Nothing magic... get rid of the powered tether. Use the Autonomous Underwater Vehicles (AUVs). Blasphemy you say? Not really. You still have a remotely operated vehicle, it is just much more remotely operated unless you're using an expendable fiber optic tether.

"But," you say, "we might lose the vehicle and they are expensive!" Yes, that is correct. In a 1999 article I wrote for Ocean News and Technology, my closing comments were, "Space satellites are launched and never return. Now is the time to launch some AUVs." And those $atellites are expen$ive. And so are our ROVs, but we've lost some of them also; some impressive vehicles such as JAMSTEC's Kaiko and the hybrid ROV Nereus, along with several others. And they have been replaced.

In papers where I reviewed the state-of-the-art of AUVs to determine "Who's Leading the Pack" in their development, I took a step further to state that "It is time to lose some AUVs." Yes, let's lose some of them. Because once you feel the return on investment (ROI) is acceptable if you do eventually lose your vehicle, then research will progress. And this is especially true in the case of Southampton's Autosub2, which was used in both the Arctic and Antarctic polar environments. The Autosub had over 382 successful missions where it surveyed over 5,000 kilometers. When told that the annual insurance for Autosub2 was going to be 95% of its value, it was decided it was better to bite the bullet and build Autosub3 as a backup. A wise decision because of the loss of Autosub2 beneath the Fimbul Ice Shelf, Antarctica, on mission 383. The ROI was worth the loss of the vehicle... and the research continued. Remember... torpedoes (essentially an AUV) are expensive, but they are ex-

Theseus being launched from the Researcher (Courtesy of ISE)

pendable. When we treat our research AUVs the same way, then we'll be able to conduct Arctic, and Antarctic, research in a much faster and more efficient manner.

But our ROVs are not being ignored. If we want to use AUVs with long range and endurance, then we can launch them to transit under the ice and then establish an ice camp (see photos) where small ROVs can be lowered thru a hole in the ice to rendezvous with them (yes, making the hole isn't easy, especially with air temperatures in the -40 to -20 C range, and water below the ice around -1 C). Then, when the AUV arrives at its destination, the ROV can dock with the AUV and connect so that data can be downloaded, the vehicle's energy system recharged and it can be sent on its merry way again. Also thru such holes, acoustic transponders can be lowered to assist the AUV in updating its navigation system. In fact, a series of them can be installed to create a long baseline navigation system.

And it's not like we haven't had AUV operations in the Arctic. There have been and they still continue. For example, International Submarine Engineering's Theseus AUV (see photos), a massive vehicle with a range of 800 km, was used to lay 174 km of its fiber optic cable (max payload was 220 km) under the ice during testing in 1995 and 1996 and their Arctic Explorer AUV conducted over 1,000 km of under ice surveys in 2010 and 2011. Other vehicles such as Southampton's Autosub and the Woods Hole Oceanographic Institution using REMUS, to name a few, have conducted additional under ice research and operations.

With that said, where are we going in the future? We know that AUVs have come of age and are being manufactured with varying sizes and capabilities. They can operate from shallow water to the depths of the Mariana Trench. And they can and do operate in the Arctic. Where we're going is toward the marriage of the ROV and AUV in the Arctic. With ROV support in critical locations, the AUV can become more efficient in completing its under-ice missions. And, with some foresight in design, because we will probably lose some of our AUVs under the ice, techniques can be established where we can eventually locate the lost vehicle and recover it. It still time to lose some AUVs... and get them back.

Maybe the real definition of ARCTIC Exploration is: AUV Robots Counter The Ice's Constraints. Time will tell.

The Green Edge Project uses an ROV to study the Arctic marine ecosystem. (Courtesy of Lisa Matthes/Green Edge project)


Theseus under the ice (Courtesy of ISE)

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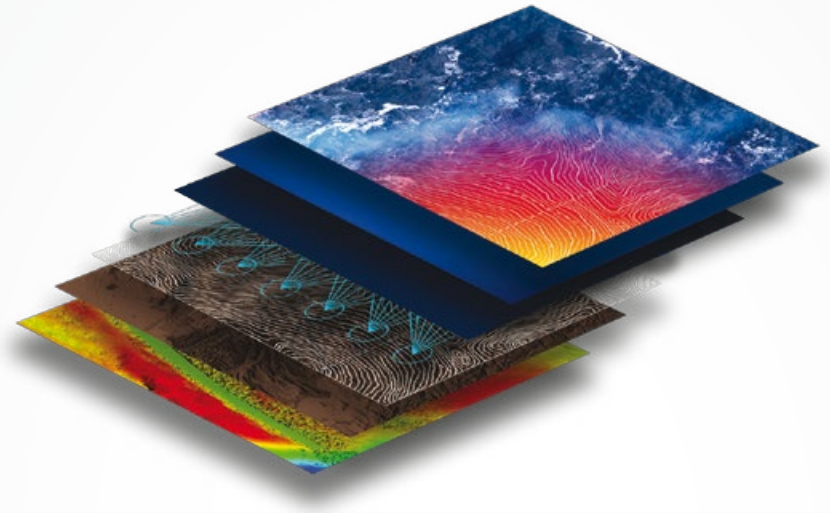

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Courtesy of PLOCAN

THE OCEANIC PLATFORM OF THE CANARY ISLANDS

A MULTIPURPOSE RESEARCH INFRASTRUCTURE WITH A BASE FOR AUTONOMOUS OCEAN VEHICLES

Carlos Barrera, Head VIMAS Area, PLOCAN

PLOCAN INFRASTRUCTURE OVERVIEW

The Oceanic Platform of the Canary Islands (PLOCAN) is a Research Infrastructure (RI) labelled by the ICTS (Unique Scientific and Technological Infrastructure) Spanish National Roadmap, as a joint initiative and co-funded by the Economy and Competitiveness Ministry of the Spanish government and the Canary Islands government, and by the European Regional Development Fund (ERDF) under the Operational Program of the Canary Islands. PLOCAN is a multipurpose technical-scientific service infrastructure that provides support for research, technological development and innovation in the marine and maritime sectors, available to public and private users. Its mission is to provide a cost-effective combination of services, including housing, operations, data, and access to the offshore multiuse platform, the integrated observatory and test site facilities. The vision is to become a world-class infrastructure offering great value services, attracting national and international users, responding to the R&D&I challenges of the marine and maritime sectors, and helping to maintain Spain and the EU at the forefront of these sectors.

PLOCAN comprises a number of specialized facilities that together provide access to study or test excellent and innovative science and technology concepts and devices in coastal and oceanic environments. It includes an observatory, a test site and a multi-purpose offshore platform. They provide data, operations and hosting services for experiments or new devices. Its main role is to accelerate research, technological development and innovation in the marine and maritime sector, as well as to provide the critical facilities that are necessary for the international scientific community and industry to carry out their experiments. By the very nature of its infrastructure and objectives, PLOCAN will also enhance and accelerate contributions to UN SDG14, the primary target of which is to "conserve and sustainably use the oceans, seas and marine resources for sustainable development» (UN SDG14).

PLOCAN offers access to both onshore and offshore experimental facilities and laboratories, operational throughout the whole year thanks to the Canary Islands excellent climatic conditions. PLOCAN also brings a broad experience managing large marine/maritime projects at national and international level.


Courtesy of PLOCAN


Courtesy of PLOCAN

THE PLOCAN OCEAN OBSERVATORY

The PLOCAN Ocean Observatory, under the name of ESTOC site, is located 60 nautical miles Northwards Gran Canaria island over 3600 meters depth, operational since 1994, for continuous (time-series) and real-time monitoring in fields such as the study of global change and ocean acidification, water-column and deep-sea ecosystems, ocean biogeochemistry and geophysics. It comprises a multidisciplinary set of autonomous fix and mobile platforms and sensors that interoperate to offer environmental impact monitoring, instrument testing, calibration and validation from shallow waters to the deep seafloor. The PLOCAN observatory delivers a double function. First, it acts as monitoring facility for coastal, regional and global ocean phenomena and ecosystems at increasing geographical scales, from shallow waters to the deep ocean. Second, it provides a testing area for new sensors and instrumentation, marine operations and training activities. The PLOCAN observatory is committed to integrate data with large scale observing initiatives, including European research infrastructures, EMSO, LIFEWATCH or ICOS, and other international initiatives such as NEPTUNE, OOI or IOOS. It also endorses and promotes the implementation of international standards and best-practices for sensor and data interoperability (EMODNet), in compliance with the INSPIRE Directive and the guidelines established for the implementation of the GEOSS.

THE PLOCAN TEST-BED

The PLOCAN Test-Bed is an area of 23 km² located in the North-East coast of Gran Canaria, with depths ranging up to 600 meters, mainly addressed for research, demonstration and operation of prototypes and novel marine technologies, especially those related to marine renewable energies, autonomous ocean platforms and sensors. The test site provides a robust and secure underwater electric infrastructure to evacuate the generated energy to the power grid connection, and a control centre for monitoring and data analysis. The marine and maritime sector is specially requiring integrating services to commercialise and bring marine technologies to the market, mainly from TRL4 up to TRL8, where large and expensive infrastructures are required to test devices at sea. PLOCAN has competences in this area from National Authorities of Spain. This Test Site will shortly be equipped with a submarine electricity and communication infrastructure, composed of two hybrid cables with the capacity to transfer up to 10MW (5MW each) of electricity from the marine test site. A third cable can be deployed on demand. The onshore electrical infrastructure is able to deliver up to 15MW to the national grid provider (Red Eléctrica de España). Furthermore, the cabling includes optical fibres for data transmission, an essential fact in order to study performance indicators and for observation of the marine devices and other observations in the area. Cables are directly connected to a land substation that is connected to Gran Canaria's main electrical grid. In addition, a SCADA and an electrical protection systems are also installed on land in order to control, protect, and monitor crucial performance indicators that can be transmitted to and assessed at PLOCAN's land facilities.

THE PLOCAN OFFSHORE PLATFORM

The PLOCAN Offshore Platform facility is a distinctive feature. A moored multipurpose facility located both close to the coast in shallow waters (30 m depth) and near to the edge of the continental shelf, and is also available to conduct complementary tests and explore multi-purpose and co-location solutions. The platform has a net surface area of 2,500 m² of research capacity, laboratories equipped, instrumented containers and the ability to permanently accommodate researchers in a building within the main dock with 1,000 m² of floor space. PLOCAN provides support to users with the transport of devices from their origin, interaction with port authorities for installation, deployment, maintenance, operations, decommissioning, consent, environmental impacts, permit management and in any other area where support may be required to successfully test the prototypes. The platform also offers land-sea bidirectional communication capabilities beyond the cable, allowing submarine communication between the PLOCAN Marine Test Site and its land base.

THE PLOCAN BASE FOR AUTONOMOUS OCEAN VEHICLES (VIMAS)

The PLOCAN Base for Autonomous Ocean Vehicles (VIMAS) comprises a multidisciplinary fleet of unmanned state-of-the-art technologies such as buoyancy driven and surface gliders, mini-ROVs and AUVs, with dedicated labs, tooling and skilled technicians and managers. Besides, the VIMAS supports missions deploying customers' vehicles in real op-

erational scenarios at local, regional and ocean-basin scale. It has a dedicated control room to manage and track the UUVs in real-time once in mission, and laboratories and warehouses to support missions' needs such as calibration, refurbishment and storage.

PLOCAN is a Highly Specialized Training Platform (HSTP) for institutions and enterprises in a wide range of topics related to marine and maritime sectors. The PLOCAN Innovation Hub offers efficient and high quality R&D&I project management services, as well as other user-oriented technological services (testing marine devices, data collection and analysis, environmental studies, etc.) and non-technological (permits, logistics, health and safety, etc.).

The construction of the Oceanic Platform of the Canary Islands is 85% funded by the European Union, the European Regional Development Fund (ERDF), the ERDF Operational Program for the Canary Islands 2007–2013, in Topic 1 "Development of the economy of knowledge", Priority issue 02.

VIMAS – A BASE FOR AUTONOMOUS OCEAN VEHICLES

Sustainable management of the seas and oceans is raised as one of the humanity challenges that become possible for a first time through the convergence of a broad range of technical development from disciplines like computing, robotics, telecom, image, biotechnology and nanotechnology, mainly. The VIMAS goal is to make available in an efficient and sustainable way all those infrastructures and equipment, enable to provide a permanent support service for multidisciplinary technological development related to underwater vehicles, instruments and machines within the marine and maritime sectors, as well as the multipurpose operation thereof, generating national and international synergistic cooperation scenarios with technology-based companies and institutions.

The VIMAS area at PLOCAN has and provides, among others, the following facilities and services portfolio:

- Permanent operational base and fleet of underwater vehicles,
- Easy, quick and reliable open-ocean access,
- Technical and logistic support for trials and operations in tank, confined and open waters,
- Multidisciplinary and sectorial technology partnership cooperation with national and international companies and institutions,
- Labs, workshops, boats and control room for test, trials and repairs, and
- Highly specialized training.

Courtesy of PLOCAN


Courtesy of PLOCAN


Courtesy of PLOCAN

Courtesy of PLOCAN

Currently, the fleet of unmanned ocean vehicles hosted by VIMAS comprises a wide representation of the main existing commercial technologies of surface (Wave Glider and Sail-buoy) and buoyancy-driven (Slocum, Seaglider and SeaExplorer) gliders, with specific payload sensor configurations, addressed to monitor respectively physical and bio-chemical variables in surface and through the water-column.

These glider units are often used to cover not only the own monitoring needs of PLOCAN at i.e. the integrated observatory within the framework of research projects (GROOM, AtlantOS, MARCET, FixO3, PERSEUS, NeXOS, etc). They are also used in scientific and demonstrative missions from regional to ocean-basin level (i.e. Challenger One) in cooperation with research institutions and companies. In addition, the VIMAS fleet is also available to support new technological developments and improvements in close cooperation with the leading manufacturers.

In addition, the VIMAS fleet includes a mini-ROV Seabotix vLBV950, mainly addressed to support survey operations in the surroundings of the PLOCAN offshore facility and rest of the test-site area. Furthermore, it is expected in short term, to expand VIMAS service-capabilities including new units and technologies (i.e. deep gliders and AUVs).

THE PLOCAN GLIDER SCHOOL

Highly specialized training it's key when working with cutting-edge technologies. For this min reason, and since 2011, PLOCAN organizes and host yearly in Gran Canaria an international highly-specialized training week (with quality certification standards) on marine robotics event under the name of PLOCAN Glider School.

The PLOCAN Glider School is a pioneer initiative that edition by edition (already setting up the number nine) consolidates its role as hands-on training and networking key-event addressed to the emerging technology sector as is marine robotics, and more specifically the one related to ocean gliders as cutting-edge autonomous-unmanned platforms for real-time monitoring in a sustainable and efficient way.

The main goal of the Glider School is to provide the best full-picture on ocean glider's state-of the-art to a selected and reduced group of attendees, from public and private sectors, interested into start-to-learn or improve knowledge on this new technological approach for ocean monitoring. Selection of attendants by CV evaluation, guarantees somehow the best teaching level quality. More than a hundred attendees from a well-represented number of countries around the world have already joined the school in past editions.

Leading ocean-glider manufacturers, related leading technology-based companies (ocean sensors, telemetry, batteries, etc.) and key international research institutions as representative glider users around the world, are joining and supporting all together the school teaching the theoretical and practical contents of the agenda, that includes glider technology concept and overview, sensor payload, mission setup in lab and confined waters, open-sea operations, data management and display, synergies with other autonomous ocean-observing platforms, glider applications users and networks, etc.

Technological development linked to ocean monitoring through the latest and most innovative technology available, as well as their direct applications within the main socioeconomic sectors linked to marine and maritime fields, are part of the PLOCAN strategic objectives as gliderport infrastructure for the East-Central North Atlantic as member of the international network EGO (Everyone's Glider Observatories) where flag-ship national and international projects, study-case glider missions and new technological developments take place, through the advantages offered by a dedicated infrastructure as it is PLOCAN.

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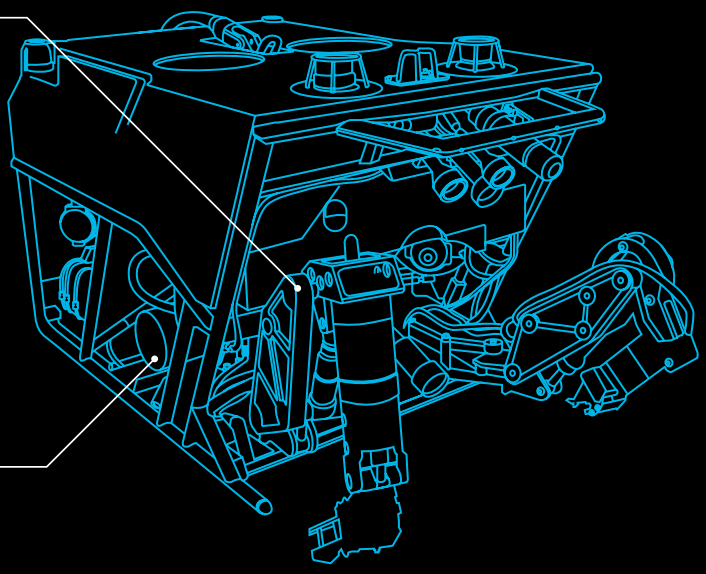

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