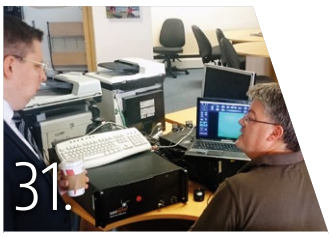
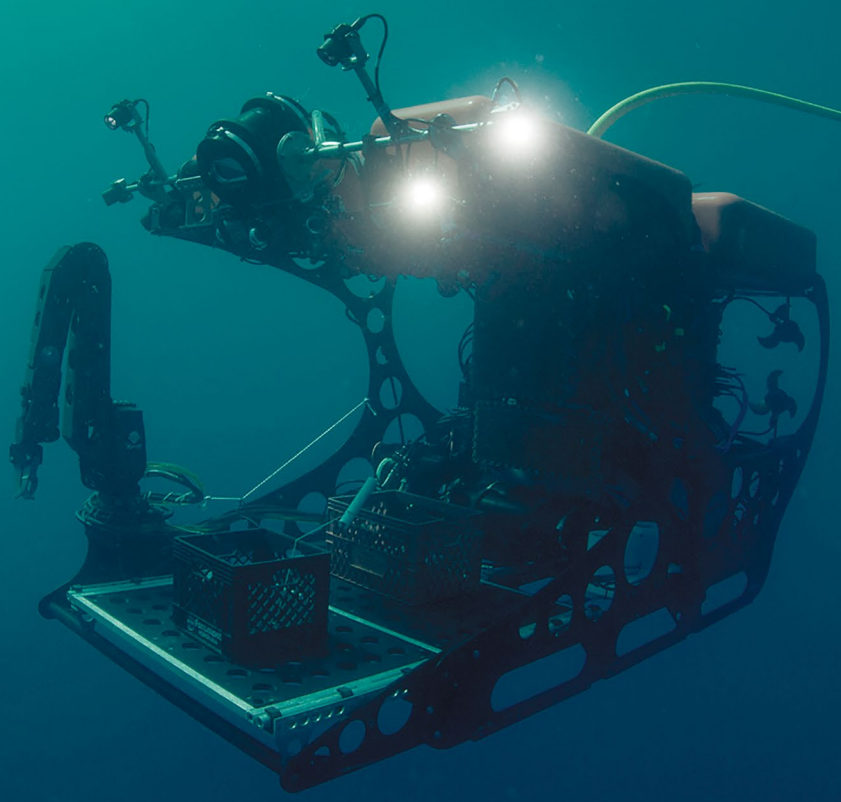
ROV PLANET





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Q4 / 2016

The magazine of choice for Subsea Construction and ROV Professionals

ABOUT

With approximately 9,000 email distributions and 2,000 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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If you have any company news you would like us to share on our website and news portal please send it to: **NEWS@ROVPlanet.com**

DESIGN WORK

If you would like any kind of design work done (full corporate branding, magazines, flyers, posters and advertisements, flash/html5 banners, bus banners, etc.) please send enquiries to our talented design team: **DESIGN@ROVPlanet.com**

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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,

Recently, I was asked the question if ROV Planet would also feature AUVs, despite our "ROV" title. The answer is yes! We will be looking at all underwater solutions that are somewhat "Remotely Operated" underwater, whether they are autonomously operated or controlled via tether.

According to the reports, the AUV market has seen an increase due to the demand in the defence and research sectors. Furthermore, in order to keep costs down, autonomous solutions are also getting wider acceptance in the commercial sector. This is the reason that we are hearing more and more news on hybrid vehicles such as the Nereid. The Nereid, a hybrid ROV and AUV vehicle designed by the Woods Hole Oceanographic Institution (WHOI), has undertaken extensive sea trials offshore Panama in late August. Louise Murray reports on these trials and I hope you will enjoy the stunning underwater images accompanying this article, as much as I do.

In this issue we are featuring at the nuclear industry that uses specialised, purpose built ROVs such as the Casey Jones, the Nano Seaker, and the Adaptable can operate in radioactive environments and do the jobs that no human could possibly perform. Bespoke developed ROVs

Finally, you can read about ROV Planet visiting the headquarters of SeeByte in Edinburgh where we had a shot of remotely flying a Seatronics Predator ROV in the ROVOP Test Tank located 130 miles away in Westhill, Aberdeenshire. I can see this becoming the norm eventually for certain operations.

Sit back and enjoy our ninth issue!

Best regards,
Richie Enzmann

UPCOMING EVENTS

08-10 November, 2016 – HYDRO 2016 – Rostock, Germany
Annual hydrography event of the International Federation of Hydrographic Societies.

14-18 November, 2016 – MATS – Southampton, UK
The Marine Autonomy and Technology Showcase organised by the NOC Marine Robotics Innovation Centre.

29 Nov – 2 Dec, 2016 – OSEA2016 – Singapore
Major biannual exhibition focusing on Asia's oil and gas industry.

07-08 December, 2016 – Deepwater Asia Pacific – Jakarta, Indonesia
Exhibition focusing on Asia's oil and gas industry.

17-18 January, 2016 – Undersea Defence Technology – Singapore
The must attend conference for the undersea defence sector in Asia.

01-03 February, 2017 – Subsea Expo – Aberdeen, UK
The World's largest annual subsea exhibition and conference.

Please check out our website on:
www.ROVPlanet.com

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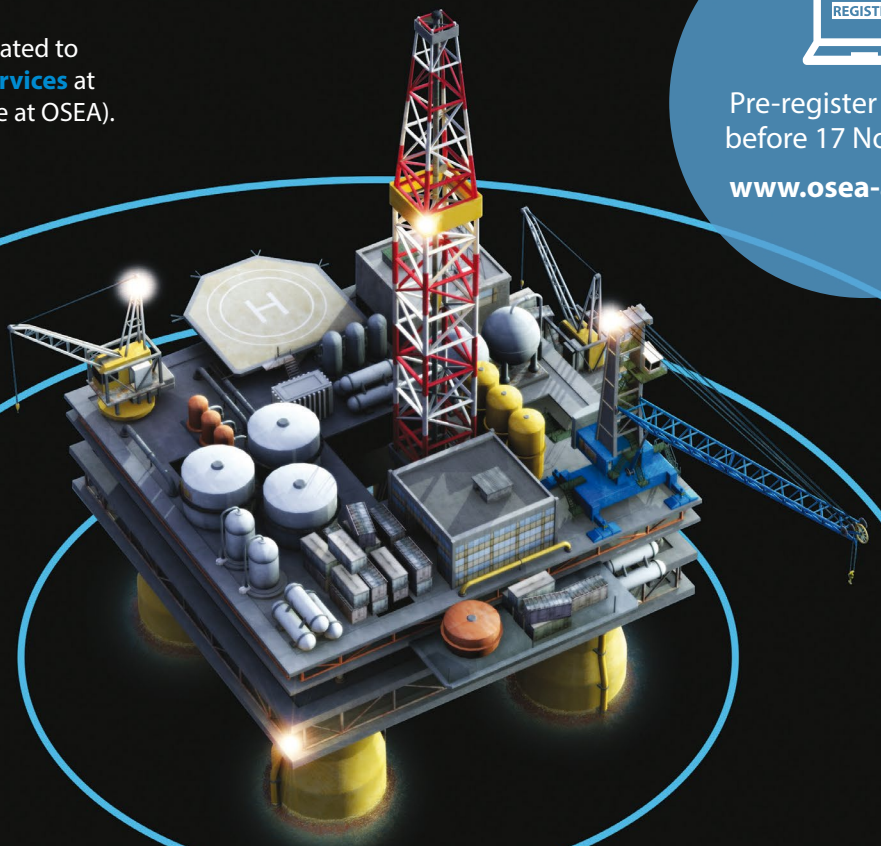
Visitors from Asia who stay for a minimum of 2 nights can get up to **SGD 100** to offset their spending in Singapore. Find out more about the **Meet in Singapore programme** at www.osea-asia.com.



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AUV MARKET TO CONTINUE TO GROW

By Ben Wilby, Analyst at Douglas-Westwood

INTRODUCTION

Many sectors within the oil & gas industry are struggling in the face of low oil prices, however, there are technologies that are finding success. The Autonomous Underwater Vehicle (AUV) sector has evolved from an emerging technology with niche uses, to a viable solution and an established part of operations in various marine sectors. A number of companies within the AUV sector have developed strong reputations as reliable providers of AUVs but there is potential for further growth.

Douglas-Westwood's new AUV Market Forecast 2016-2020 considers the prospective demand for AUVs in the commercial, military and research sectors over the next five years. We see demand for units continuing to grow over the forecast period, with demand in 2020 expected to be 49% higher than in 2016. This will be driven by continued high levels of military and research activity as well as consistent growth from the commercial sector. The prospects for growth in the use of AUV technology in the commercial sector are good – as a comparatively underutilised and developing technology, it will likely take time for the sector to fully mature. Yet with growing acceptance from operators and a strong focus on research & development, demand for AUV is forecast to increase for the foreseeable future.

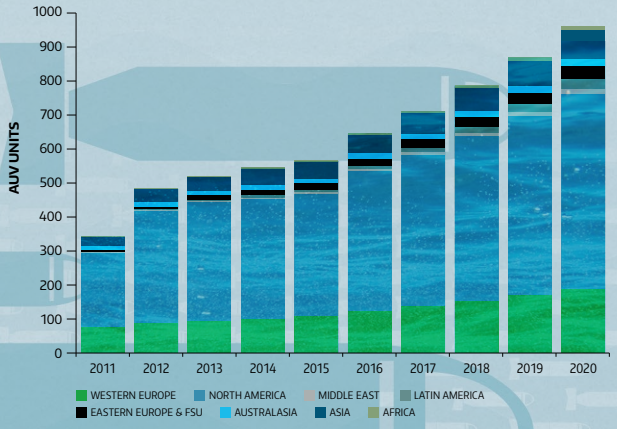

Figure 1: Global AUV Demand by Region 2011-2020
Source: Douglas-Westwood, World AUV Market Forecast 2016-2020

EMERGING TECHNOLOGIES

In the commercial sector, the future of AUVs is intrinsically linked with further technological advancements – the technology is yet to reach a level where oil and gas operators consider AUVs a vital aspect of operations.

AUVs have a number of limitations that are hindering uptake in the commercial sector, these include: battery life, autonomy and manipulation ability. Currently, AUVs average under 24 hours battery life and this is significantly reduced if the unit is required to work in deepwater – thrusters are one of the largest drains on power. Consequently, current research is focused on improving battery life, either through improvements to existing technology or the introduction of new battery types. Many of these battery types are still conceptual and are likely to be a number of years from commercial availability.

Full autonomy is also an important target, many in the industry have told us that units are; 'not as autonomous as we perceive them to be.' Much of this is linked to battery life – with units requiring regular intervention for power purposes – however, it also relates to the current limits of programming and artificial intelligence.

At a commercial level, improved manipulation ability will arguably be the most important factor for increased uptake of AUVs. Units currently have limited ability to manipulate equipment once they are underwater, limiting their use to inspection and surveys. This is a major difference between AUVs and ROVs – the latter can be fitted with arms that can be controlled manually. There are a number of projects focused on improving manipulation ability, including Eelume who have developed a swimming robot concept. This AUV utilises a snake like design to allow for better manoeuvrability and will be capable of adjusting the valves and chokes on subsea trees. A collaboration agreement with Statoil and Kongsberg to further develop the concept was signed in April 2016.

Eelume's AUV design does not require the unit to resurface in order to be charged. This can take place on the seabed with the unit sending data up to the surface while charging. This solution improves a number of issues – increasing autonomy and removing many of the concerns over battery life. The development of "resident" AUV installations will be integral to growth of the technology for oil & gas operations. Future developments could see subsea bases for AUVs that are based around a series of marginal fields – dramatically increasing the value proposition. Subsea 7 are one of a number of companies that already have 'subsea resident' AUVs in development.

MARKET FORECAST

The market demand for AUVs is expected to increase over the forecast at CAGR 10%, with every sector seeing positive growth due to increased utilisation of the technology. The military is expected to remain the greatest user of AUVs with demand in 2020 for over 700 units – 73% of total demand. AUVs have a range of uses in the military including: anti-submarine warfare, mine countermeasures, oceanography, search & rescue as well as special operations.

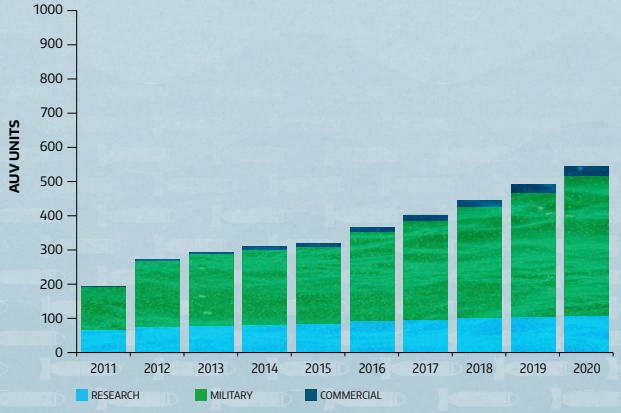

Figure 2: Global AUV Demand by Sector 2011-2020
Source: Douglas-Westwood, World AUV Market Forecast 2016-2020

Using AUVs for these tasks reduces costs and limits risk to military personnel. In recent years, military investment in research & development has been reduced, with only specialised projects receiving funding. This is primarily due to the widespread availability of commercial off the shelf (COTS) AUVs from a range of different companies – this was not the case ten years ago. Specialised projects and unique AUVs are still being sanctioned and built. A key example is Boeing's new Echo Voyager, a 51 foot AUV capable of staying underwater for over three months at a time.

The greatest growth in AUV usage is expected in the commercial sector – predominately from oil & gas operators. This will be a key market for the technology – despite the volatility of oil prices – as operators begin to understand the cost saving potential of AUVs. Consequently, the next few years are expected to be vitally important for AUV manufacturers and operators – both need to capitalise on increased interest before higher prices potentially lead to a return to the norm. However, low oil prices have reduced budgets and stymied investment in new technology, presenting a barrier to growth. Therefore, the onus will be on AUV manufacturers and operators to highlight the benefits of the technology.

We expect demand for AUVs from the commercial sector to grow at a CAGR of 20%, with demand in 2020 105% higher than 2016. Over the forecast, commercial demand will represent only 4% of the total, highlighting that the technology remains a niche solution within the industry.

Despite accounting for the second largest portion of demand, the research sector will grow at a slower rate than the other two sectors. Research institutions typically utilise AUVs for a range of applications and have built units as research/engineering projects in their own right, or as a development test bed for new sensors, as well as to gather field data to support research efforts. Many institutions now purchase COTS AUVs rather than build them, however, there is often a great deal of integration work required in order for the AUV to meet project requirements. With the rise of modular, easy to change and open source platforms, this is likely to become less of an issue within the sector.

We expect demand in 2020 to be 14% higher than in 2016, rising at CAGR 3%. Research institutions typically do not require high numbers of AUVs and usually prefer to modify existing units where possible.

AUV technology was first developed in robotics departments within US universities – often in collaboration with the US military. Consequently, North America remains the largest market for AUV demand, accounting for 61% of total demand over the forecast. The uptake rate in other regions has been slower, however, we expect to see some demand very region. Western Europe is the second largest market, accounting for 19% of total demand – largely originating from the military sector.

Asia is expected to be a large user of AUV technology and a number of militaries in the region are believed to already have sizeable fleets. China and India (the two countries believed to have the largest AUV fleets in the region) have developed their AUV technology internally. These units are not included in the forecast but we still expect Asia to account for 9% of demand, the third highest behind North America and Western Europe. Commercially however Asia will account for 20% of all demand, a result of the high levels of installed infrastructure in the region. Much of this demand will come from survey work, both for oil & gas activities and renewables.

Another important part of the market are Gliders which are an extremely well established aspect of the market and are typically used for oceanographic sensing and supporting military and scientific research. We forecast gliders based on additional yearly supply and expect consistent growth to 2020. In 2016 we expect to see 168 additional units utilised, growing to 326 units by 2020. The vast majority of these units will be based in North America – representing 70% of total supply over the forecast.

CONCLUSION

AUV technology is still maturing and research & development spend remains high in universities, research institutions and from commercial operators. AUV demand is expected to increase substantially over the forecast, with demand in 2020 expected to be 50% higher than in 2016 – growing at CAGR 10%. The AUV sector is one of great promise, the technology has been widely accepted by the military and is seen as a vital tool in a number of research areas, yet uptake in the commercial sector remains limited. With technological improvements and new designs regularly coming to market, strong growth in the sector is expected. However, operators and manufacturers will need to clearly demonstrate the benefits of the technology if AUVs are to move beyond a niche solution in commercial environments.

OCEANEERING EXPANDS ITS GEOGRAPHIC OPERATIONS FOR AUVS INTO WEST AFRICA

Oceaneering International, Inc. announced that it is expanding its presence for Autonomous Underwater Vehicle (AUV) survey services to the West African region.

Oceaneering currently serves the U.S Gulf of Mexico with a fleet of state-of-the-art commercial AUVs, designed for high resolution and efficient survey operations in water depths reaching 4,500 meters. The Company is mobilizing one of its 3,000 meter rated AUVs, which is capable of performing deepwater geophysical hazard and pipeline inspection surveys. This advanced AUV provides clients with the necessary deepwater survey capabilities for pipeline surveys, as-built surveys, block surveys, and pipeline inspections.

"Africa is a growing market. By expanding our AUV operations, we will have the opportunity to support new and existing customers more efficiently, and meet the increasing demand for survey services in deepwater blocks of Africa with cost-effective integrated solutions. With our reliable AUV technology, we enable our customers to make informed decisions by providing them with accurate, high resolution information of the seafloor as well as their subsea infrastructure," said Pat Mannina, Vice President, ROV – Americas and Global Survey Services.

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Subsea Technology and Rentals (STR) is a specialist technology company providing rental and sales services globally to the offshore marine sectors. For over 20 years, STR has delivered mission critical solutions to support offshore survey, ROV, IRM, positioning, environmental, and subsea construction sectors. STR's mission is to offer all its customers a competitive edge by delivering integrated, forward thinking technology and innovative engineering solutions, complete with flexible and dedicated support from project planning to project completion.

LOCATION

STR is headquartered in close proximity to the port of Great Yarmouth and strategically placed to serve their local, national, and international clients. From their location on the East Coast of England they have direct links to major European shipping ports, direct access to London Heathrow Airport for global delivery and the use of a daily overnight trunker service to industry hub Aberdeen.

REGENERATION

After nearly 20 years of operating under the established name of Sonar Equipment Services, STR began an exciting new phase under new ownership. In 2013, with a reinvigorated push to provide the best services in their sector and with sustainable growth the company moved into a modern, purpose-developed building under the new title STR to better reflect the diversity on offer to its customers.

Following the change in ownership, premises, and a complete re-brand, investment and growth have steadily continued across all business lines. This has led to a significant investment in staff for both on and offshore support, rental equipment inventory, product research and development, cable moulding and calibration facilities.

As an innovative company STR understands the importance of developing new technology and delivering class-leading services to give their customers the best solutions. Continual investment in the latest marine technology has seen their spectrum of rental equipment increase in order to satisfy all marine and subsea activities.

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REASEARCH & DEVELOPMENT

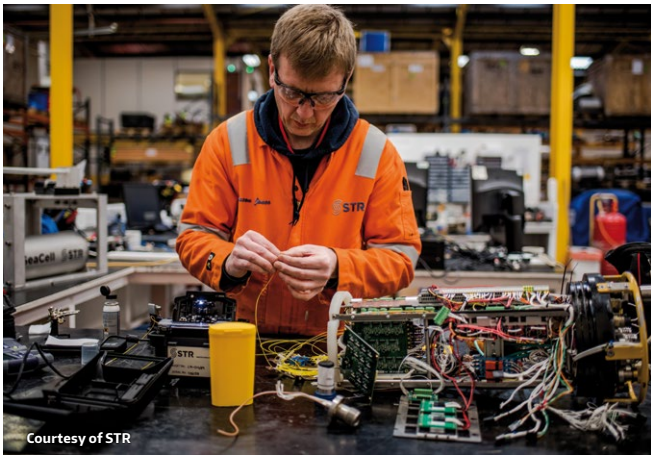
The product development team at STR has a proven track record of providing functional technical solutions to meet their client's challenging operational requirements. STR has manufactured trusted solutions for seafloor investigation and inspection for over 20 years and has recently moved into the delivery of high performance ROV video cameras, underwater lasers, LED lights and uninterruptible power supplies for ROV sensors.

FACILITIES AND SERVICES

STR operates state of the art test and engineering facilities to maintain their rental equipment inventory to the highest standards, in line with manufacturing specifications. The site even features a fantastic hyperbaric pressure test chamber and acoustic tank. These are regularly used in a range of testing, including their calibration services.

CALIBRATION FACILITIES

To support the maintenance programme of STR's extensive range of rental assets, STR has invested in state of the art calibration facilities to conduct manufacture equivalent calibrations in-house. With collaboration from industry leading manufacture Valeport, their calibration facility can support customers requiring fast turnaround 3rd party calibrations.


Courtesy of STR

PERSONNEL

STR equipment supply can be complemented with highly skilled offshore survey engineers to attend vessel mobilisations and support their customers' offshore operations. Their offshore personnel are qualified in a relevant engineering discipline and certified for offshore deployment to effectively integrate into their customer's offshore team.

CABLE MOULDING

The STR cable moulding and termination facility offers expertise in the design, manufacture and testing of OEM and custom electrical, video and fibre optic cables for use in underwater, topside and other harsh environments.

Their OEM equivalent polyurethane moulding processes are proven to deliver the highest quality product without compromise. Alongside the supply of connectors, cables, terminations and mouldings, STR specialise in fibre-optic and oil-filled pressure balanced cable solutions. Their trained fibre optic technicians can support singlemode and multimode fibre cables and can provide their clients worksite diagnostics and re-termination services.

AGENCIES

Unparalled experience in marine technology has meant many of the leading industry manufacturers have selected STR to represent their interests to provide expert procurement guidance. With industry recognised expertise in the field of sidescan sonar and sub-bottom profiling, STR have been selected to represent leading sonar manufacture EdgeTech as their sales and service centre for UK customers.

So, as you can see STR boasts the skills, equipment, and industry experience required to meet all of your marine technology needs. If you have any further questions or would like to contact STR, follow the details below. Their team looks forward to helping you succeed.

Courtesy of STR

THE APPLICATION OF ROVS IN THE NUCLEAR INDUSTRY

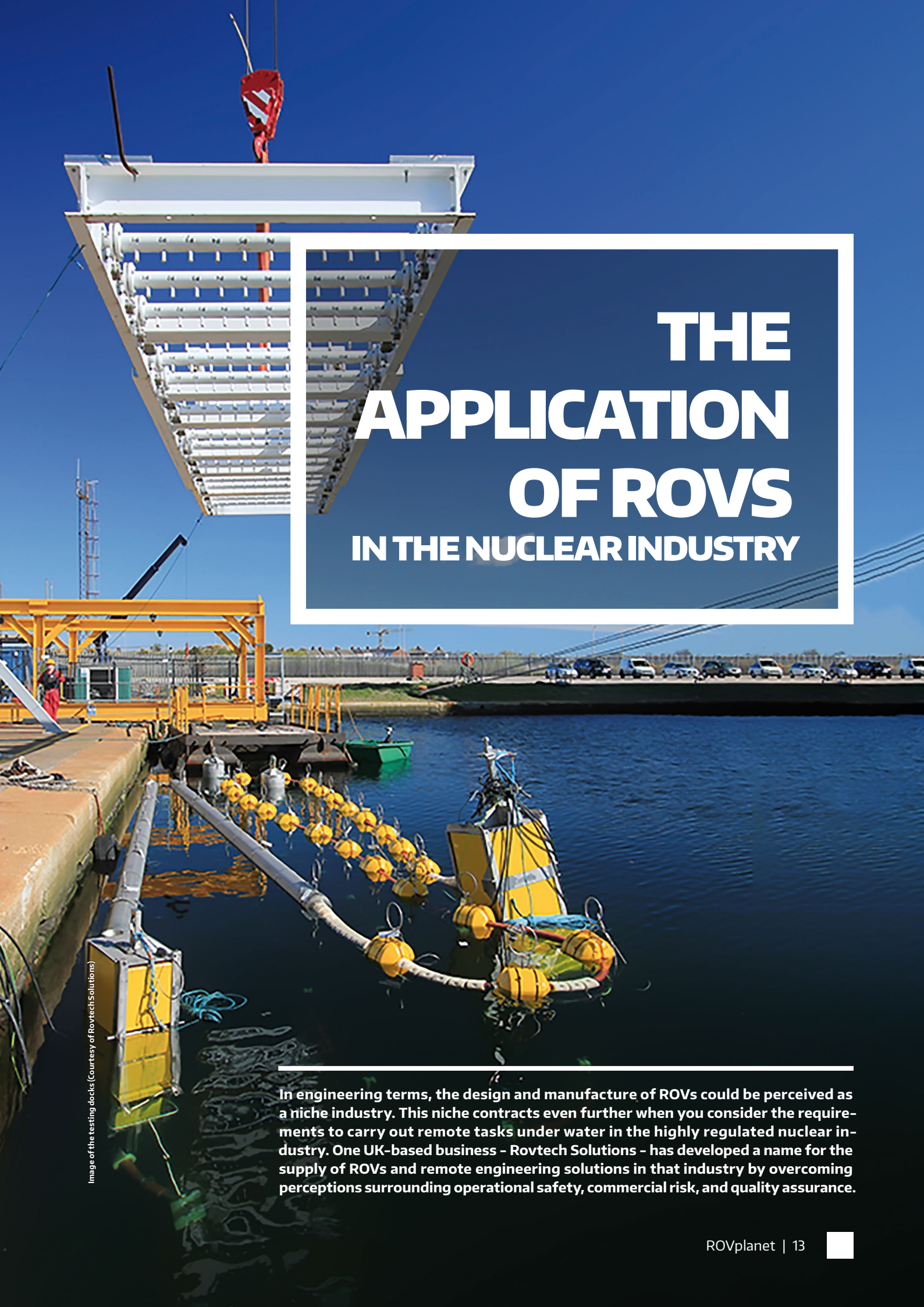


Image of the testing docks (Courtesy of Rovtech Solutions)

In engineering terms, the design and manufacture of ROVs could be perceived as a niche industry. This niche contracts even further when you consider the requirements to carry out remote tasks under water in the highly regulated nuclear industry. One UK-based business - Rovtech Solutions - has developed a name for the supply of ROVs and remote engineering solutions in that industry by overcoming perceptions surrounding operational safety, commercial risk, and quality assurance.

ROVTECH SOLUTIONS Ltd
Harsh Environment Problem Solvers

THE FIRST CHALLENGE

In 1957 an incident at the Windscale nuclear reactor facility and plutonium-production plant in Cumbria, NW England resulted in the United Kingdom's most serious nuclear accident. The Windscale plant consisted of two air-cooled nuclear reactors. The accident occurred on October 8, 1957, when No. 1 reactor got out of control, causing the adjacent uranium cartridges to rupture. The metal released began to oxidise, releasing radioactivity, and causing a fire that burned for 16 hours. The fire left about 10 tonnes of radioactive fuel melted in the reactor core. The contaminated Windscale reactor was subsequently sealed, and parts of the facility remained inaccessible with the condition uncertain until the late 1980s when clean-up begun.

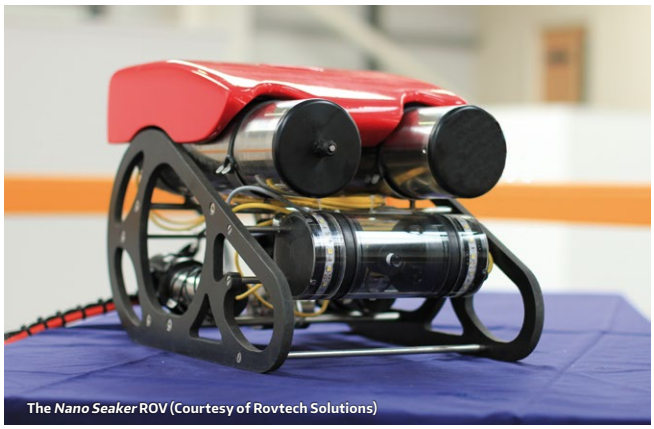
In 1988 Rovtech Solutions were contracted to design and supply an inspection ROV to inspect the historical damage within the water ducts underneath the Windscale piles. The Windscale project served to demonstrate the viability of mobile submersible inspection platforms in the nuclear industry, and eventually led to the formation of a fleet of many and varied machines. ROVs are now used worldwide in operational nuclear facilities and in decommissioning. Since making a name for themselves in the nuclear industry with such a high profile project, the company's nuclear expertise has grown, making them industry leaders.

FURTHER CHALLENGES

Since the 1950's the nuclear industry has stored irradiated fuel in concrete ponds. The water in the ponds cools and shields the fuel rods before and after use in the reactors. There are up to 700 nuclear storage ponds worldwide in various stages of use: some serving working reactors and some storing legacy waste which is awaiting decommissioning. A number of ponds at Sellafield, measuring up to 100m x 20m and up to 20m deep, have stored spent fuel for over six decades, and are now in the process of decommissioning. Prior to demolition they must be emptied of various forms of radioactive waste using highly versatile vehicles to sort and segregate spent fuel, manipulate and cut up inventory, and clear the radioactive sludge which covers the floor of the ponds.

Decommissioning of the nuclear industries' legacy ponds is a significant, technical challenge. The complexities of safely manipulating spent fuel and intermediate level waste underwater in a radioactive environment have to be overcome. The use of remote tooling and equipment is now common and the deployment of tooling, sensors, cameras, and sonar equipment on an ROV is now the norm.

The *Casey Jones* ROV (Courtesy of Rovtech Solutions)


The *Nano Seaker* ROV (Courtesy of Rovtech Solutions)

ROVTECH SOLUTIONS

Since their initial success in the nuclear industry, Rovtech have developed their niche ROV capability and become one of the best known ROV manufacturers in the UK. They now supply Inspection and Work Class vehicles to Sellafield Ltd in order to assist with the clean-up of some of the nuclear industry's legacy ponds.

Rovtech Solutions Ltd have been providing remote engineering solutions for harsh environments in the offshore and nuclear sectors for over thirty years. Based in Barrow-in-Furness, Cumbria, Rovtech Solutions design, develop, and manufacture ROVs, Inspection Systems, Underwater Cameras, LED Lighting, Manipulators, and many other bespoke items. The Rovtech team includes Mechanical and CE&I design, computer modelling, fabrication and machining, electronics lab, and full testing facilities. With the exception of certain specialist components 90% of the products supplied by Rovtech are manufactured at their facilities in Barrow in Furness. This 'made in Cumbria' ethos is something which Rovtech are very proud of.

TESTING

Their 50m × 10m dock frontage, 10m deep, has proven invaluable in the proving and testing of equipment and the training of operators. The composition of the sediment on the floor of the dock is much like that of some of the nuclear facilities in which the ROVs are commissioned to work: compacted and stratified, and made up of a mix of fine sediment, sand and organic waste. A clean indoor 27m³ tank completes and compliments their wet testing capability.

ROVTECH ROVS FOR NUCLEAR

In 1999 Rovtech were commissioned to design and manufacture an ROV for work inside the First Generation Magnox Storage Pond. Initially designed as an 'eye-ball', The Seaker was deployed to inspect and record the position and condition of inventory within the facility. Further development resulted in the Adaptable Seaker, which incorporated a manipulator skid and uprated vertical thrust. Further developments have included hydraulic shears and the addition of a vertical gripper to enable the movement of spent fuel elements, resulting in the movement of over 30 tonnes of fuel ready for export from the facility. A recent development incorporates an award winning jet pump system onto The Adaptable Seaker, nicknamed Casey Jones, this vehicle has the ability to remove sludge from specific work zones within the ponds, thus clearing the way for operations.

Much of their industry-specific knowledge and experience has been incorporated into the design of Rovtech's most recent vehicle, the Nano Seaker. The Nano Seaker – a mini inspection and intervention vehicle – has been designed as a modular construction. A full strip out and re-build can be completed in minutes by a semi-skilled operator wearing full nuclear PPE (double layer rubber gloves and air fed suit). This means the vehicles have a quick turnaround for maintenance, but what's most important is that it significantly reduces the level of radiation exposure of the maintenance crew. Further enhancements such as magnetic coupled, seal-free thrusters and certain radiological adaptations have been included to make it the most advanced, nuclear-specific ROV available.

ROVTECH'S NUCLEAR PEDIGREE

The nuclear industry demands SQEP (Suitably Qualified Experienced Personnel) from its Tier 2 and Tier 3 suppliers. Rovtech have 180 years of combined experience in nuclear design and manufacture. They have also invested heavily into research covering the effects of radiation on material/components such as micro-processors, LED arrays, and lenses. Practical knowledge is vital in order to avoid design pitfalls. This includes the use of the correct base materials, metal coatings and plastics, and the avoidance of contamination traps which make decontamination difficult, and in some cases impossible.

Working within one of the most highly regulated industries, Rovtech must adhere to strict approvals, quality management systems and exhaustive test procedures in order to assure the safety of its products before they are deployed. Often referred to ISO9001 on steroids, a typical LTQR (Lifetime Quality Record) for an ROV will include exhaustive documentation detailing origins of components etc., and can fill multiple A4 file binders.

DIVERSIFICATION AND COLLABORATION

Conscious of the finite amount of work to be carried out in nuclear wet facilities (there are only so many nuclear ponds and so many ROVs to deploy in those ponds) Rovtech have taken a collaborative approach to remote engineering solutions provision. Rovtech are now working alongside some of the largest Tier 2 businesses in the nuclear industry, adding their niche skills to supplement projects throughout the UK, Europe, and Japan.

Going back to their roots in the offshore industry and building on regular international trade in marine inspection systems, Rovtech are developing strategies for the growth of their international trade in oil and gas and marine. A network of international agents is being sought in North and South America, Africa, Asia, and Europe to promote their range of ROVs and inspection equipment.

The *Adaptable* ROV (Courtesy of Rovtech Solutions)

WORLD'S MOST PRODUCTIVE RESEARCH VESSEL

AND SCHMIDT OCEAN INSTITUTE SHARE GREENSEA CONNECTION

By Marybeth Gilliam

My uncle, Robert Fredericks, was the acoustic engineer onboard Columbia University's research vessel, the RV Vema, in 1967 (the year I was born). He traveled on the three-masted schooner for a year mapping and studying our world's oceans. One of the areas he helped map was the Mariana Trench – the same area Schmidt Ocean Institute will be researching with their new work-class ROV, SuBastian.

SCHMIDT OCEAN INSTITUTE

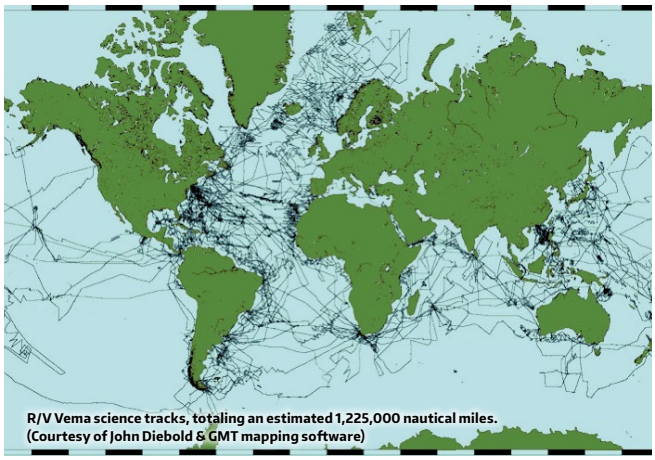
R/V Vema approaches the Piermont Pier, ca 1960. (Courtesy of Lamont Archives)

Robert Fredericks shares original ship's log and maps for Columbia University research vessel RV Vema's work in the Mariana Trench. (Courtesy of Greensea)

As a part of the Greensea Systems, Inc. team, I have been fortunate enough to be a part of the new ROV build for Schmidt Ocean Institute (SOI). Greensea built the telemetry and control bottles, provided navigation, and developed OPENSEA, the software operating platform for SuBastian. This amazing machine is the first of three vehicles that will work together to reach the bottom of the Mariana Trench.

By the time of her retirement in 1981, the Vema had collected data over 1,225,000 nautical miles (2,269,000 km) and was recognized as the world's most productive research vessel. In fact, the work on the ship helped to confirm the continental drift theory. Several seafloor features are named after the vessel including the Vema Trench in the Indian Ocean. Today this incredible ship, first built in 1923, is a cruising yacht sailing under the name Mandalay in the Caribbean.

As I listened to my Uncle Bob tell stories about his adventures on the Vema, I felt so grateful for all those around us investing in oceanology and proud of Greensea's part in supporting today's research. The state-of-the-art navigation and control system running on SuBastian is also used by NOAA, Monterey Bay Aquarium Research Institute, the Canadian Scientific Submersibles Facility, University of Hawaii, HURL, SCRIPPS, and many other terrific research organizations. Thank you to all those before us, and those ahead of us, for your work to better understand our amazing planet.



R/V Vema science tracks, totaling an estimated 1,225,000 nautical miles. (Courtesy of John Diebold & GMT mapping software)

The SuBastian ROV at the MBARI Test Tank (Courtesy of SOI/Carlie Wiener)

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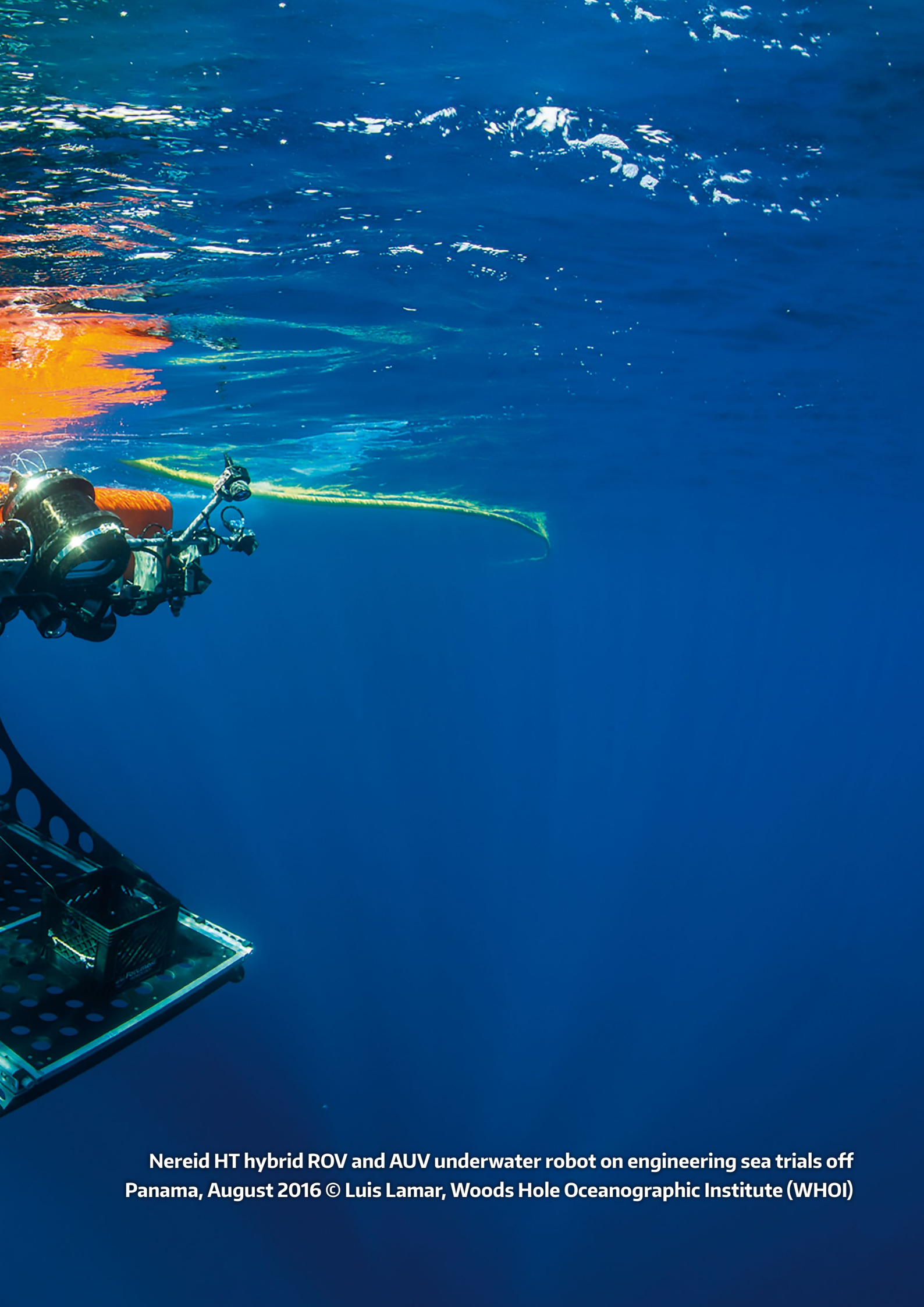
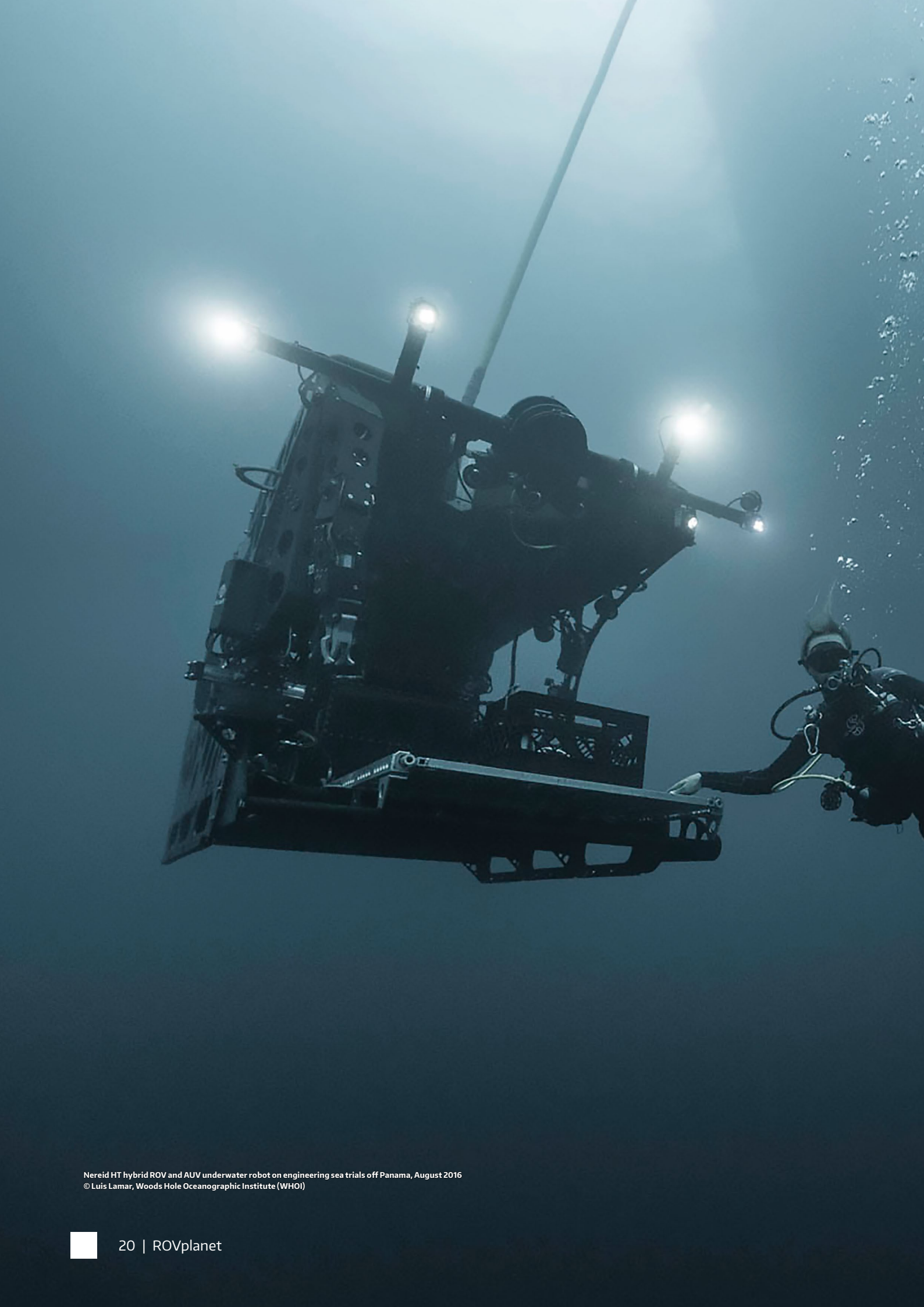


Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016 © Luis Lamar, Woods Hole Oceanographic Institute (WHOI)



Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016
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NEREID HT HYBRID ROV AND AUV ON ENGINEERING SEA TRIALS OFF PANAMA

By Louise Murray

Nereid Hybrid Tether or Nereid HT is a new hybrid underwater vehicle developed by Woods Hole Oceanographic Institution (WHOI). Its creator, Andy Bowen, principal developer and engineer on the project, has thirty years of experience in developing some of the most ground-breaking underwater vehicles ever built, from the deep-sea manned submersible Alvin, to the 11-kilometre-capable hybrid ROV Nereus. Of its successor, Nereid, Bowen said, 'The battery-powered Nereid is principally a scientific tool, but longer term we expect to see many of the design concepts that we are developing being applied in underwater robotics and control systems in the oil and gas sectors, marine science and archaeology, and in the military.' WHOI is actively seeking partners who wish to apply these new technologies to a range of emerging applications.

The Nereid HT vehicle depends on a raft of antecedent technologies developed at WHOI.
'We had to solve a lot of difficult problems to operate Nereus at 11000 metres. A lightweight tether cable was an operational necessity since traditional ROV design solutions would have resulted in a massive and very costly system. Other technologies that we have implemented on Nereid include the large amounts of rechargeable energy that can be stored on-board the vehicle, a refined manipulator design coupled with very efficient hydraulic power unit, and highly effective propulsion, lighting and control systems,' explains Bowen. Taken separately, these are all incremental advances in design, but when combined with the powerful software embedded in the Nereid HT, are transformational.

The hybrid vehicle is both an ROV and an AUV and is best thought of as capable of operating on a spectrum anywhere between these two traditional classifications. The robot is smart enough to switch between control modes that range from low bandwidth acoustics to WHOI's new optical modem or gigabyte Ethernet connections provided by physical connections such as expendable or light weight reusable optical tethers. In an acoustic "tethered" mode, Nereid will be checking for the presence of an optical modem connection. Once the autonomous controller senses that it can hand over control back to the pilot via the optical modem, it does so. Bowen describes this as a kind of adaptive autonomy, a hierarchical system of control according to the availability of different means of communications, a key characteristic of this new hybrid vehicle model. One of the most advanced, versatile and cost effective unmanned submersibles in the world, Nereid HT was dived on an engineering cruise for the first time to 2500 metres off the coast of Panama in August 2016. During these trials, the Nereid vehicle was operated with a lightweight reusable tether and via the WHOI optical modem as a tetherless ROV.

The acoustic, optical and expendable tethering system is unique, and the innovative reusable tether cable is in the final stages of a US Patent office application. It consists of a two component umbilical, a small 8mm reusable steel-reinforced cable coupled to a 50mm lift tether section spliced through a transition hose. The lift tether ensures adequate strength for retrieval and deployment as well as being specially designed to have sections transitioning from heavy to positive buoyancy, resulting in a tether with an "S" shape, all of which can be drawn onto a small electric winch. This differential buoyancy of the lift tether effectively decouples the Nereid from the ship's movements allowing more simple streamlined operations than with conventionally tethered vehicles. This new tether design was used to successfully to support ROV-type operations at 2,500 meters for the first time in Panama. The Dalio Foundation supported the vehicle development, and as part of its Dalio Ocean Initiative also made the expeditionary vessel Alucia available. The Alucia – a 55 metre, 1396 tonne vessel, originally built in 1974 as a heavy lift ship and launch/recovery platform for diving and submersible operations,

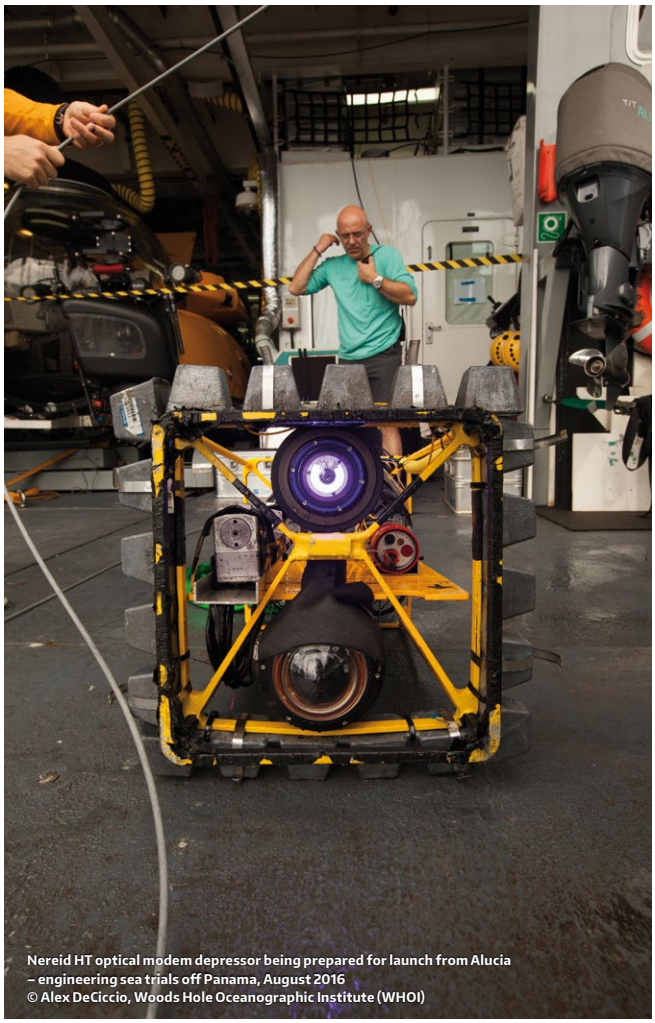
Triton 3300 3 man submarine being launched from the Alucia back deck
WHOI engineering sea trials off Panama, August 2016
© Alex DeCiccio, Woods Hole Oceanographic Institute (WHOI)

was extensively refitted between 2008 and 2012 for its current science and filming role. 'What we are trying to do on-board Alucia is to give the ship, and others like her, the capability to access depths that would be impossible for a ship of this type using conventional technology – we are aiming for 5,000 metres using this novel, light weight reusable umbilical system. It's a much smaller diameter tether than would typically be used for ROVs of this size and capability.' said Bowen. The reduction in size of both the winch system and other shipboard handling systems means that many more vessels can accommodate vehicles like the Nereid; which also needs a smaller support crew. Importantly, the system also does away with the requirement for high cost charters of ships with dynamic positioning. Ultimately, this pattern of reducing the footprint of the ROV will result in shipless systems, able to perform complex missions by working over long distances, utilising a nested strategy of communications and autonomy.

Research engineer Chris Taylor acted as the pilot for the sea trials in Panama, 'The pilot interface has been built to make Nereid accessible as possible to a wide range of potential pilots,' he said. The software was written by WHOI's own engineers. Ex-gamer Taylor says it is very easy to use. An Xbox joystick is the pilot's direct interaction to manoeuvre the vehicle and scale thruster outputs, and is also used to control pan and tilt of the cameras. The other main interface is the Graphical User Interface or GUI. While providing the usual information for tethered operations, it also allows

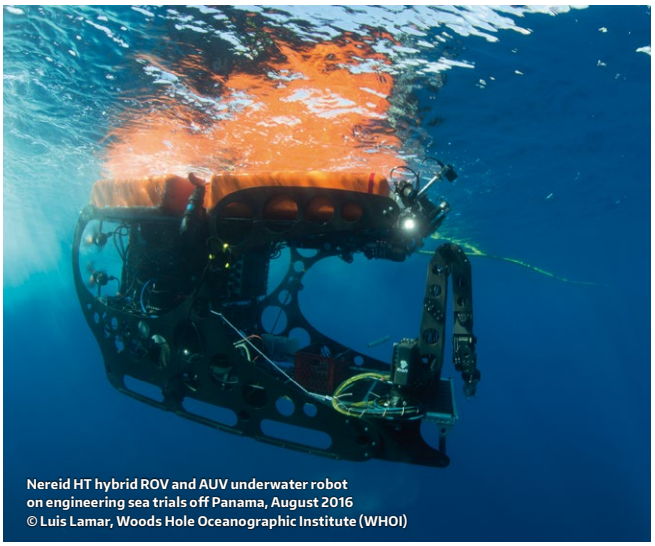
access to engineering data like motor controller status for the thrusters, battery statistics and status, hydraulic power systems and valves, and importantly in a battery powered vehicle, power management systems to monitor overall power and active consumption. A subset of this information is available to the pilot/supervisor even when the vehicle is operating as an untethered system. 'The thrusters are our number one power consumer on the vehicle,' says Taylor, 'with lights and hydraulics being the next largest. We have optimised our hydraulic power unit to minimise power consumption when operating the manipulator arm, grippers and related systems. When the manipulator arm is not actively moving, the pump basically goes into this idle/low state of power consumption and the HPU's unique design exchanges fluid logic for a system controlled by its input brushless DC motor and associated controller. The arm is custom built by Kraft TeleRobotics to a WHOI design that was originally developed for the Nereus project, and has since been refined.

WHOI is well known for its stunning visual imaging capability having partnered its submersibles and camera systems with film productions from the BBC, NHK, National Geographic and Discovery Channel. The camera systems on Nereid were designed in the Advanced Imaging and Visualisation laboratory (AIVL) at WHOI. Evan Kovacs, Director of Photography at AIVL explains the imaging systems that can be deployed on the Nereid HT, 'We wanted to use imaging to completely overhaul the ROV control room interface by better connecting the pilot to the vehicle's entire field of view.'



Nereid HT optical modem depressor being prepared for launch from Alucia – engineering sea trials off Panama, August 2016
© Alex DeCiccio, Woods Hole Oceanographic Institute (WHOI)

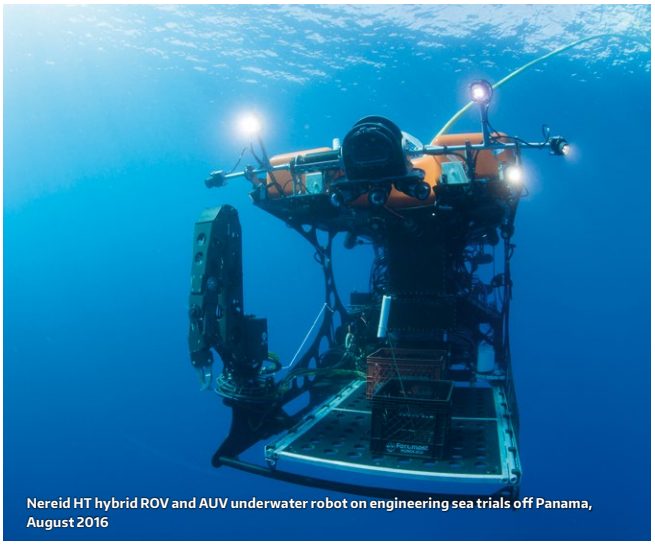
MV Alucia on engineering sea trials off Panama, August 2016. Alicia is a 52 metre, 1400 tonne research vessel. | © Alex DeCiccio, Woods Hole Oceanographic Institute (WHOI)



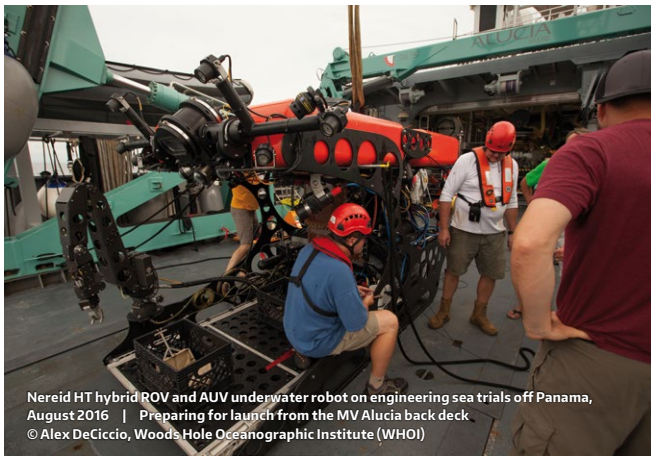
Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016
© Luis Lamar, Woods Hole Oceanographic Institute (WHOI)

There are three main camera systems on the vehicle in its peak imaging configuration: a triscopic 3D setup made up of 3 cameras in a single custom housing; three separate housed HD Cameras that record a panoramic view, plus simpler situational awareness cameras that view the basket and manipulator arm actions; there are also hook-ups for hires cinematographic and speciality cameras. The triscopic system produces three stereoscopic baselines with fixed baselines of 4.45cm – 8.9cm with a viewing angle of 50 – 60 degrees. The pilot can switch between them for an appropriate viewpoint. This calibrated feed can be used to map archaeological sites; or oil field artefacts, or shipwrecks before salvage is attempted, and to aid in salvage or intervention planning. The panoramic camera set gives the operator a live feed with a 160 degree angle of view. The three feeds are stitched together using software jointly developed between AIVL and SONY to produce a seamless live output to the control room.

'Separately, 3D and panoramic imaging capabilities are not new, but shipboard on-the-fly panoramic processing with the stereo overlay absolutely is,' adds Kovacs. The 3D feed can also be integrated into the panorama on the central



Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016



Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016 | Preparing for launch from the MV Alucia back deck
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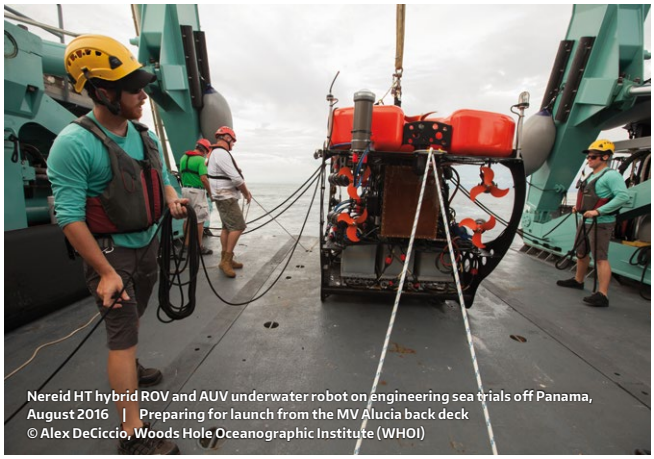

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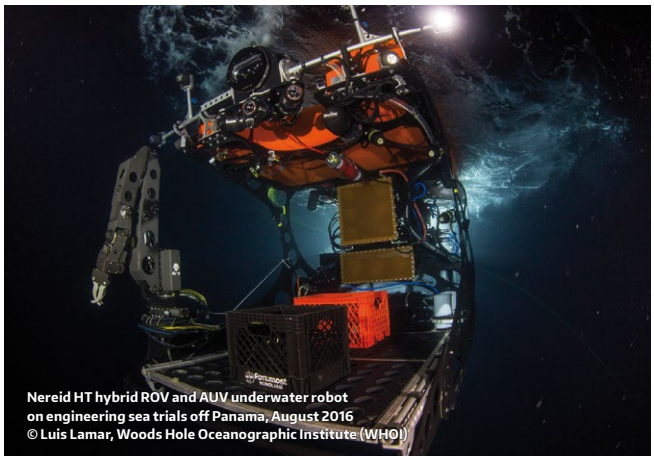

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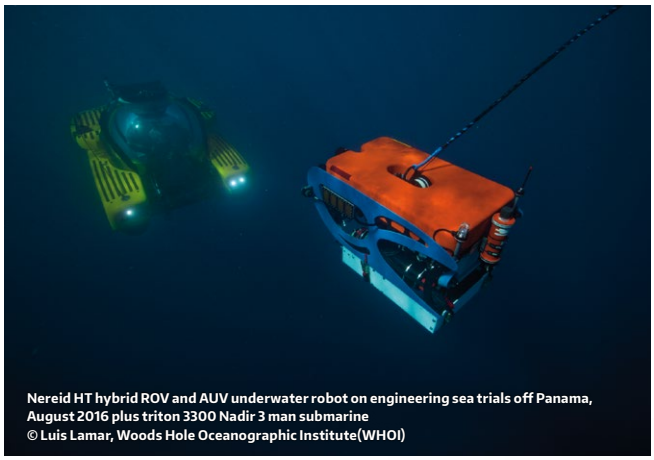

Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016 plus triton 3300 Nadir 3 man submarine
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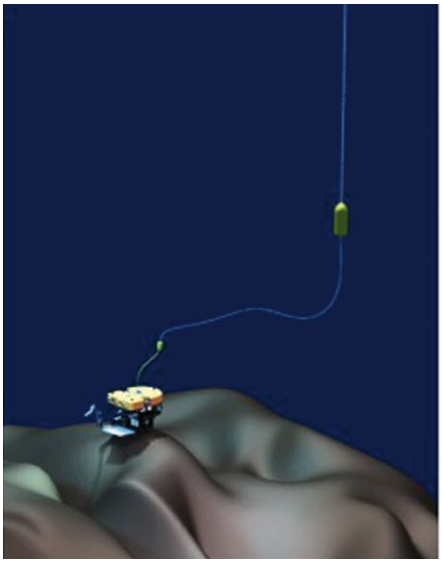
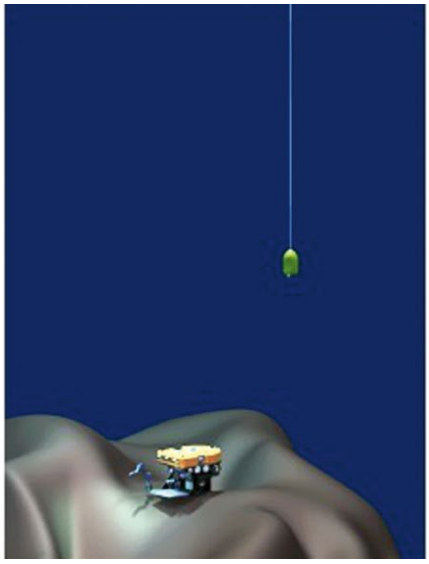


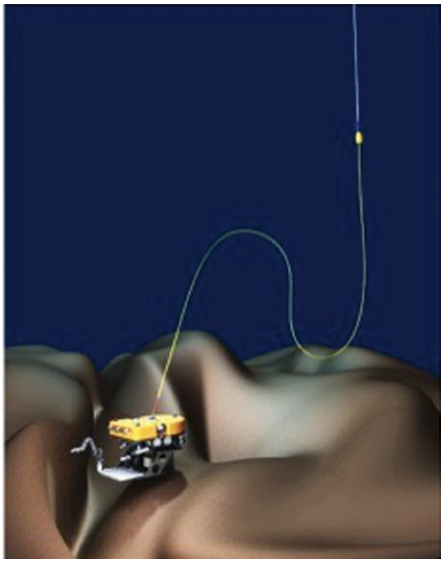
LIGHT-FIBER TETHER

Practically unlimited bandwith with 20 km horizontal standoff.



FREE-SPACE OPTICAL

Through-water optical communications at ranges up to 100+ meters for complete freedom from a tether



SMALL FOOTPRINT TETHER

Light conventional tether (CTD wire) capable of trickle-charging with minimal on-board infrastructure

Nereid HT hybrid ROV and AUV underwater robot on engineering sea trials off Panama, August 2016
Control room with Chris Taylor, research engineer and pilot in the centre. screens show the view from the panoramic camera system. | © Luis Lamar, Woods Hole Oceanographic Institute (WHOI)

screen, accurately mimicking human vision. One major advantage is to provide the pilot with a much better sense of immersion in the environment. The panoramic mimics the way human eyes work, where peripheral vision is very important, making it much easier to spot things said Chris Taylor, 'It was like night and day, compared to a single high definition camera system, just spectacular. I can see where pilots would use the Panoramic camera systems continuously, then deploy the 3D system where depth perception was critical, say where we have to gather up precise geological or biological specimens.' Ideally a single wraparound screen would replace 3 monitors. 'The Panama cruise configuration of top of the range imaging was driven by the need for a live broadcast to the Exploratorium in San Fransisco,' said Bowen, 'obviously the vehicle is tooled according to its mission, and for simple intervention tasks would only have a utility HD video camera and lights.'

When operating as a tetherless ROV WHOI's new optical modem technology, provides the operators with real-time control, including full motion video uplinks and direct downlink control of thrusters, manipulators etc.. The revolutionary WHOI-designed system allows total control over the vehicle off tether, and Panama was the first test of the modem for bi-directional communications. Norman Farr, an optical engineer at WHOI is the designer of the system, said 'We can wirelessly control the untethered vehicle in autonomous mode while transmitting live video back to the pilot. Its very exciting to have a link that is just rock solid, one that you don't really have to worry about, I feel that all of our work has paid off.' It took the team over five years to reduce the form factor of the modem to a workable size. The current modem operates using LEDs. The wavelength of light used is determined by the operating depth and levels of ambient light. Most of the time in the biologically productive coastal waters of Panama 50 metres was achieved. 'Earlier tests confirm that in clearer water conditions a range of up to 100 metres is to be expected. In Panama, bi-directional communications worked effectively at over 10 MB/s, technically speeds of 20 MB/s is possible.

The new Nereid hybrid tether system means that this highly portable robot can work from many different vessels, and the technology can be accessible to many companies and organisations due to its lower build and operational costs. Its sliding scale of control versatility, from fully piloted to completely autonomous means that it can fulfil the role of both an AUV and an ROV in a single mission, and thus have the potential to further cut costs. And its virtual tethering via the optical modem opens up the possibility of entirely new mission types where global experts or remote engineers can tap into its live visual output feeds and participate and contribute remotely to expeditions or inspections. Bowen envisages a future where small but highly capable hybrid vehicles like Nereid could be as common a vessel staple as the ship's zodiac, ready to deploy at a moment's notice.

VEHICLE SPECIFICATIONS

DEPTH CAPABILITY 2500 m, scalable to 5000 m

SIZE 3.56 m × 1.8m × 1.55 m

WEIGHT in air – 2000 kg

CABLE – CTD CABLE Rochester,
CABLE – LIFT TETHER South Bay Cable, connectors MacArtney

MANIPULATOR ARM Hydraulic 7 function, 6 degrees of freedom built by Kraft TeleRobotics to a custom design originally for the Nereus ROV, refined for Nereid.

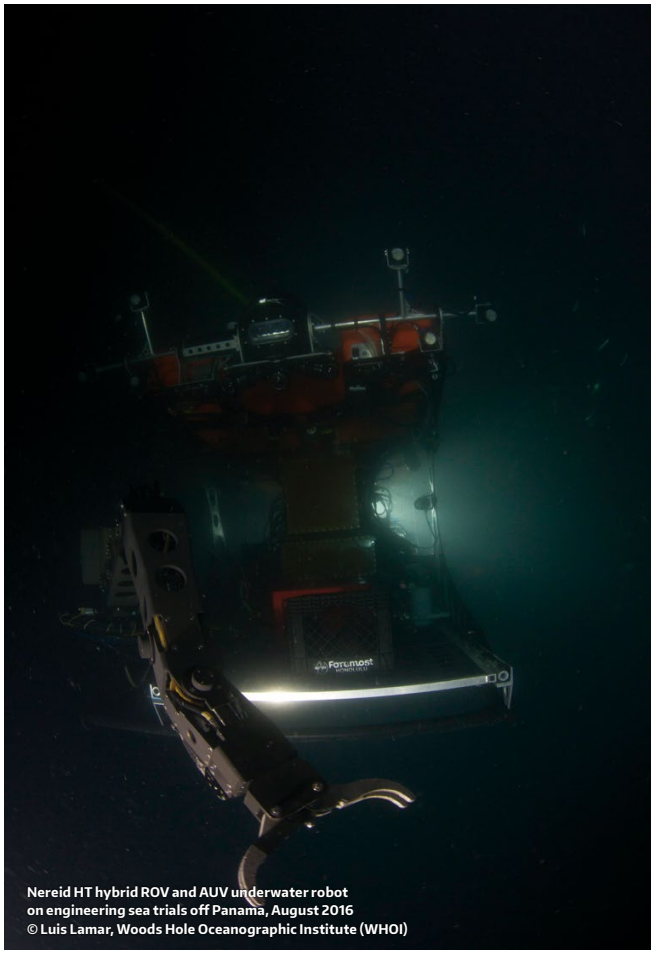
THRUSTERS 8x brushless DC electric thrusters patented WHOI design

BATTERIES rechargeable 18 kWhr Lithium ion battery packs (Southwest Electronic Energy Group) in a WHOI designed enclosure-12 hour operation

ELECTRONICS AND SOFTWARE are all WHOI proprietary builds

SENSORS Simrad Mesotech altimeter, Paroscientific depth and Microstrain heading sensor, with doppler velocity log and inertial heading reference readily added. Additional interfaces for sensors or other tools/payloads.

NAVIGATION AND COMMS – Sonardyne for navigation and acoustic communications. Optical modem WHOI design.



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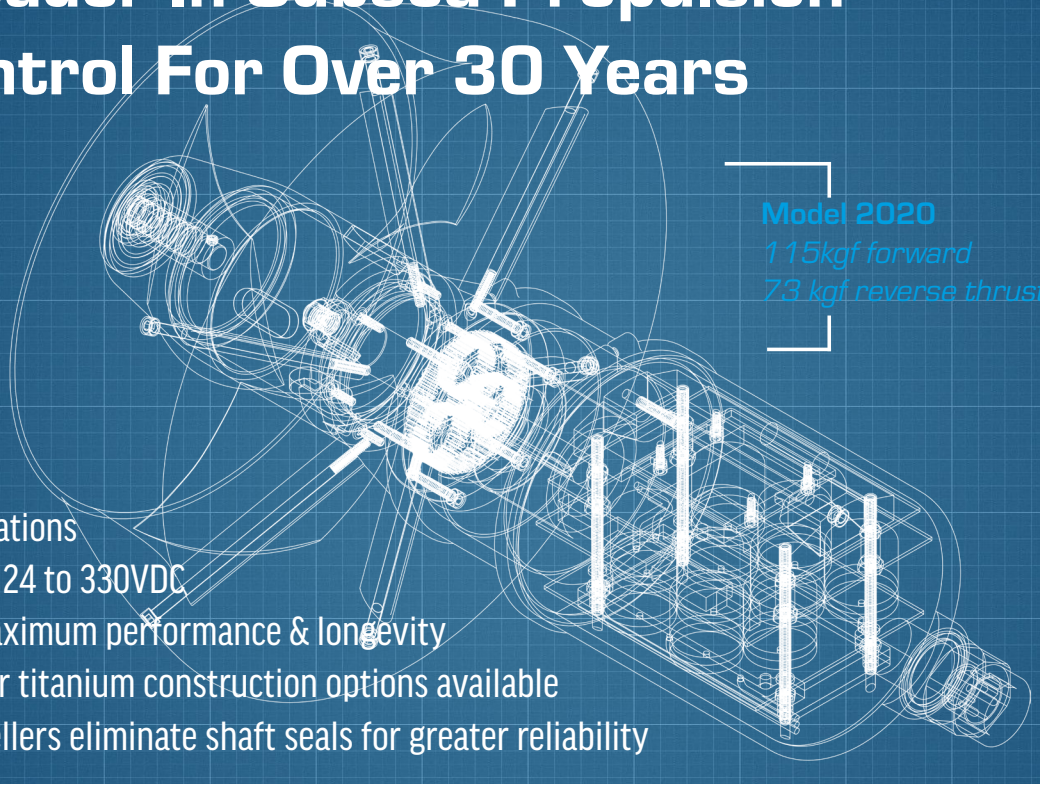

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FRESH THINKING DELIVERS A SMART SOLUTION THAT DRAMATICALLY REDUCES RISK AND COST

Subsea construction and life-of-asset integrity management are increasingly dependent upon high levels of complex instrumentation, data management and processing systems.

Being a specialist solutions provider in subsea construction, integrity and IRM systems, Ashtead recognised the need to simplify the integration of sensor packages and to provide integrated monitoring and sensing systems based on common proven building blocks.

Ashtead has successfully deployed a range of applications with varying degrees of complexity, providing vital data during subsea construction and life of asset operations.

These applications use common hardware, software and systems integration methodologies to integrate gyro packages, depth gauges, inclinometers and other sensors to provide autonomous packages that can be deployed, used and retrieved by both divers and ROV systems.

The level of connectivity that the Ashtead core system provides within a common software and hardware framework, allows simplified selection of a wide range of connection options to suit specific configuration needs and to allow scalability from the simplest to most complex of operations.

ATTITUDE MONITORING SYSTEM (AMS)

This is a widely used tool for subsea structure installation and orientation. It has been used on subsea manifold, template, suction pile, wind turbine pile and flow-line applications to provide orientation and attitude information and can be configured autonomously via topside control and monitoring system.

The system has been successfully integrated with LBL and USBL positioning networks including Sonardyne Mk5 and 6G Compatts via both ROVNav and Dunking transducers, Kongsberg cNodes via vessel using HiPAP and cPAP to position ROV and autonomous Benthos acoustic modems, allowing highly flexible integration to existing construction and IRM support acoustic networks.

Simple to use, in-built functions provide a significant improvement in operability and powerful capabilities that can significantly improve safety as well as reducing survey time.

All AMS systems can undertake all the dimensional controls observations remotely via an in-built RF link. Using this function, the surveyor can do all the required calibrations including downloading of latitude of the fabrication yard and then the deployment location to the gyro without having to physically climb onto the structure.

The Ashtead AMS system also provides visual output of gyro and battery information via subsea visual displays allowing both stand-alone diver operation and ROV monitoring in the event that an acoustic link is not available.

DEFLECTION MONITORING SYSTEM (DMS)

The DMS extends the use of common building blocks and interfaces further by providing real-time monitoring capabilities for large suction pile installed structures.

Subsea Construction Attitude Monitoring System

- Proven track record
- Flexibility in operation
- Reduced risk
- Enhanced safety features

For more information contact your local Ashtead office or visit us online: www.ashtead-technology.com

The suction pile relative depths are monitored at each of the four corners of the structure and are integrated into a common data stream via the same communications and management hub used on the AMS system. The DMS is also capable of providing fully segregated dual independent control and communications, allowing continued seamless operation in the event of a complete system failure.

In addition to measurement of depth at each of the piles, the differential pressure is also monitored in real time to provide feedback of the pressure to avoid collapse of the suction piles in the event of excessive force being encountered during pile insertion.

Ashtead's DMS supports acoustic telemetry via Kongsberg C-Node and HiPap, Sonardyne 6G data Transponder and Benthos 926 series Modem and most other transparent modems may also be utilised.

Working closely with Kongsberg, Ashtead were the first company to use cNode transponders, cPAP and topside Cymbal transceivers for transparent data telemetry in April 2016.

Using a series of common software library blocks and functions to provide communications, display management, data logging and visualisation, allows rapid application configuration to match specific client needs in terms of data connectivity, local logging support as well as presentation of data.

Courtesy of Ashtead Technology

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seebyte

SEEBYTE'S COPILOT:

FLY YOUR ROV FROM HALF WAY AROUND THE WORLD AT THE TOUCH OF A BUTTON

By Katie Rittoo, SeeByte

The job of an ROV pilot is a complex one: they have to be both highly skilled and highly trained in order to navigate vehicles through difficult environments as efficiently as possible. Precision, a sharp eye for sonar, and a steady hand are all vital for success, especially when faced with a multitude of real-world challenges. It's one thing flying an ROV in a testing pool, but fighting currents hundreds of metres under the sea whilst navigating through complex structures is another thing altogether.

Furthermore, although ROVs are undeniably an indispensable tool in the Oil and Gas industry, they don't come cheap. The vehicle itself can be an expensive piece of kit: ideally not something to be carried off course at speed into a harbour wall. And in addition to the cost of the ROV itself, one must also consider the cost of kit and sensors, support vessels, cable for the umbilical and – of course – a specialist pilot to fly the ROV.

ROV pilots are commonly employed on a contractor basis, and as those familiar with the industry will know delays in the project can quickly cause costs to spiral. With the Oil and Gas industry facing turbulent times, it's more important than ever to consider the impact of such unforeseen costs. This article will look at software developments for ROVs that not only optimise how the pilot flies the vehicle, but also provide solutions that will help save money and generate further income.

NAVIGATING WAYPOINTS

In the past surveying has typically relied upon expert piloting skills to keep the ROV on a set course at a predetermined speed, heading, and height from the seabed. The pilot has to account for currents from all directions in order to create a smooth path for the ROV to travel on whilst collecting data.

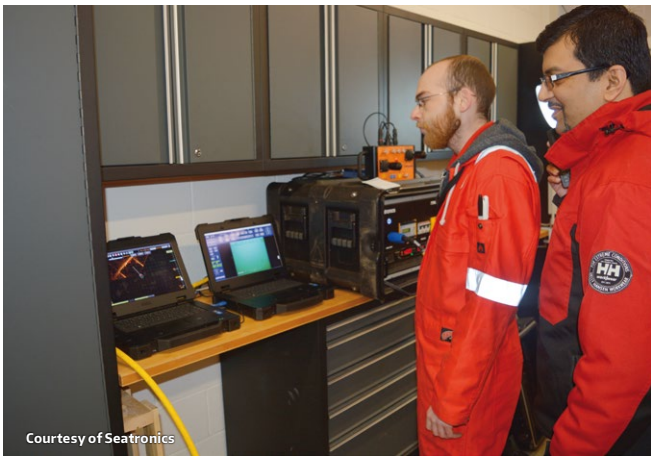
Often times the investment in a skilled pilot can be compromised if the ROV cannot be made to steer the course. Software which allows the ROVs route to be planned using waypoints means that the ROV is able to maintain a pre-laid course and offers a stable platform from which to gather data. Stability is of paramount importance when gathering data. Equally important as surveying for data, is the ability to keep the vehicle still whilst inspecting a point of interest or using manipulators to perform a task.

The capabilities of the ROV rely on the piloting, and this in turn ultimately relies on the navigation software underpinning it. There has been a surge in software developments aimed at providing pilots and ROV users with the most sophisticated tech to get the most out of their ROV. The aim of these is not to replace the operator with a fully automated piloting system. Rather these act as an aid to enhance the pilot's experience. Software packages are now available that allow the user to get the most out of the vehicle's on-board sensors by consolidating all the information into one comprehensive interface from where the vehicle can be navigated.

This technology allows the user to control the vehicle using point-and-click navigation overlaid on to the real-time sonar image. The pilot is then able to fly the ROV to a specific point literally at the click of a mouse.

Courtesy of Seatronics

Courtesy of Seatronics


Courtesy of Seatronics

COPILOT

One such software package is SeeByte's CoPilot. CoPilot permits pilot controlled auto-transit and stop-and-hover, whilst providing automated sonar tracking and movement relative to a target. This allows the vehicle to inspect a point of interest with greater precision. This is all done through a straightforward point-and-click user interface. With the recent addition of mosaicking technology, users of CoPilot are now able to generate multibeam imaging sonar mosaics in real-time. The tool can be used to quickly generate maps of the environment in order to help improve the ROV pilots' geo-spatial awareness.

Today, standard solutions like SeeByte's CoPilot can have a positive and direct impact on the operation of the ROV. The beauty of CoPilot is that the surroundings can drastically change, yet the point-and-click interface remains consistently simple. Navigating using waypoints or through point-and-click gives the pilot more time to evaluate the best course of action; if a waypoint looks to be out of position the pilot can easily adjust this in advance.

The waypoint navigation offered by CoPilot integrates directly with the vehicle's navigation and control system. As many an experienced pilot will know, poor communication links with the ROV can quickly put a stop to operations. With the piloting software actually integrated into the vehicle itself, when the vehicle loses signal it will automatically stop and hover. Or if there is poor yet sufficient connection it will continue to the next waypoint.

SMALL DATA; BIG POSSIBILITIES

The beauty of waypoint navigation is that it only requires very small amounts of data to be transmitted. Small data means low bandwidth, and this opens the door to new possible means of transmitting data and communicating with the vehicle. The link between a topside laptop and the ROV via the umbilical ensures full communication and control. CoPilot can then be remotely accessed on the topside laptop. As the commands in CoPilot require very low bandwith with only small packets of data being transmitted, piloting an ROV via WiFi or satellite commu-

Courtesy of Seatronics

Richie Enzmann at the SeeByte HQ (Courtesy of SeeByte)

nications becomes a viable option. Now anywhere with an internet connection can become a potential ROV piloting station.

Will this mean fewer pilots offshore? Not initially, but it does mean that expert pilots can contribute to a mission from any point in the world at any time. Instead of being on top of the ROV in a vessel or rig, controlling the vehicle via a joystick, the piloting can be done from any location in the world. SeeByte has already demonstrated this concept by helping customers fly their ROVs in locations as far afield as Bahrain and San Diego from offices in the UK. Using just a WiFi connection, SeeByte was able to pilot the ROVs with exactly the same degree of control as a pilot flying the vehicles onsite.

This not only makes life easier for the pilot, but also for the support crew. With traditional ROV piloting, the support vessel and crew will ideally be positioned as close to directly above the ROV as possible. Now the supervisor and support crew can be anywhere, even in relatively remote locations.

TRIAL RUN

A trial was carried out at the ROVOP Test Tank facilities in Aberdeen in collaboration with Seatronics, an Acteon company. There Richie Enzmann from ROV Planet was given the opportunity to fly the Seatronics Predator ROV remotely from SeeByte HQ in Edinburgh using CoPilot. The Predator is a versatile inspection class ROV. Its compact and portable structure allow it to operate in all sectors, as well as, ensuring easy deployment and operation. SeeByte chose to collaborate with Seatronics and the Predator ROV due to its reliability, technologically advanced electronics framework, and stability whilst under SeeByte control.

Using a WiFi link to communicate with the CoPilot node on the Predator, Richie was able to fly the ROV as if he was operating the vehicle locally from a vessel. With the ROV in the water, he was then able to use the CoPilot interface to navigate the ROV around the tank based on the live sonar feed. Richie was also able to use video to inspect points of interest from a closer angle. We were able to keep in touch with the Seatronics team on site via phone, and they were then able to launch and recover the ROV as needed. Once under SeeByte's control, the Predator engineers had minimum interaction with the vehicle due to the autonomy of the task.

Steve Mullan, ROV Engineering and Operations Supervisor, Seatronics, said, 'Eliminating the need for an operator to be physically present at the surface controls of the Predator has been an aspiration for the ROV Team at Seatronics for some time now.

'The innovation demonstrated by SeeByte in remotely controlling the Predator is exceptionally impressive. This process widens the scope for remote diagnostic intervention and the ability for a pilot to complete specialised tasks from anywhere in the world.'

The future of ROV piloting, and indeed ROV operations in general, could face a potentially drastic overhaul if remote piloting becomes a widespread reality. Remote ROV piloting opens up the potential for pilots to carry out tasks in locations away from the shore, or even from offices on the other side of the globe. You could be forgiven for assuming that ROV pilots were one occupation unlikely to benefit from the recent trend of working from home. However with the current developments in ROV technology it may just well be on the horizon.

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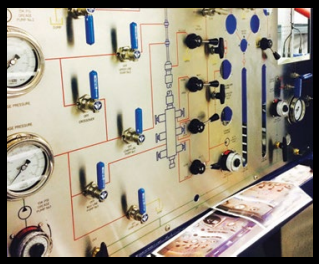

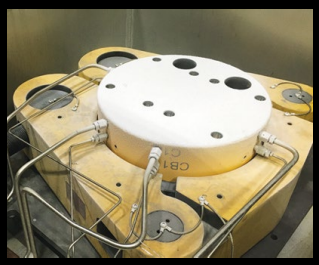


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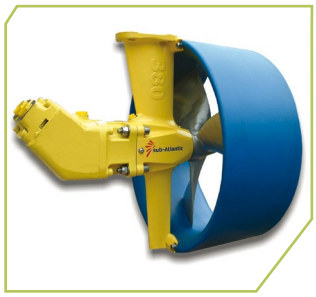

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