

UT TWO

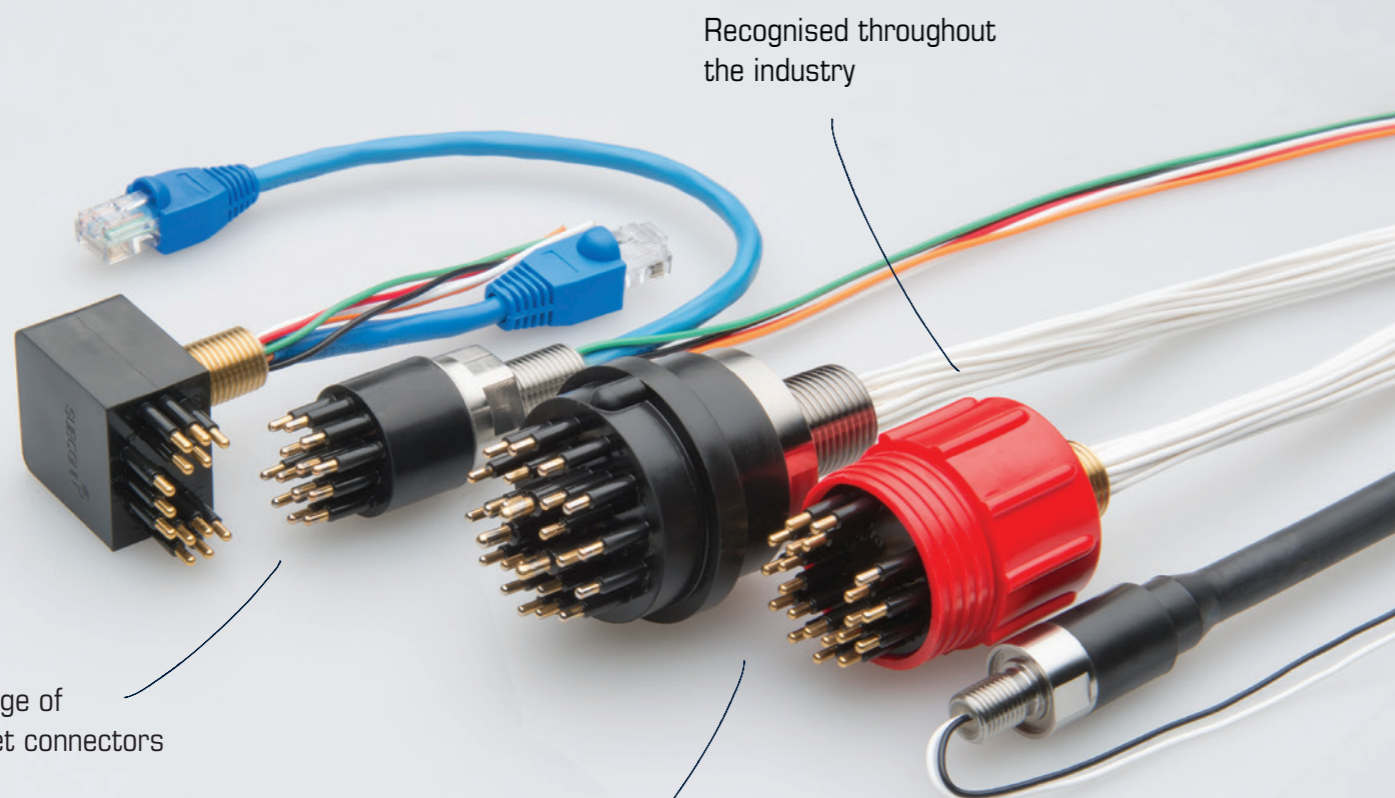
UNDERWATER
TECHNOLOGY

100th ISSUE



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Wet-mate connectors



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Full range of Ethernet connectors

More than 45 years proven track record

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SOCIETY FOR UNDERWATER TECHNOLOGY

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Editor: John Howes
John@ut-2.com
+44 7859905550

Editorial Assistants:
Scott Chegg

Production:
Sue Denham

Advertising:
Zinat Hassan
UT3subsea@gmail.com

Tel: +44 (0) 845 6522 483
Mobile: +44 (0) 781 1200 483

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100th ISSUE



C-Kore's fault-finding system

NEWS



NEWS



NUMBERS



SURVEY



PROPULSION



SONAR



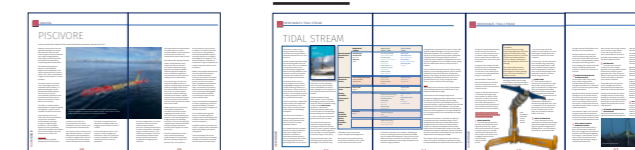
CABLES



IMAGING



TIDAL



FRAM SØR FEED

Schlumberger has announced a contract award from Equinor for the front-end engineering design (FEED) of a 12-well, all-electric Subsea Production Systems (SPS) project in the Fram Sør field, offshore Norway.

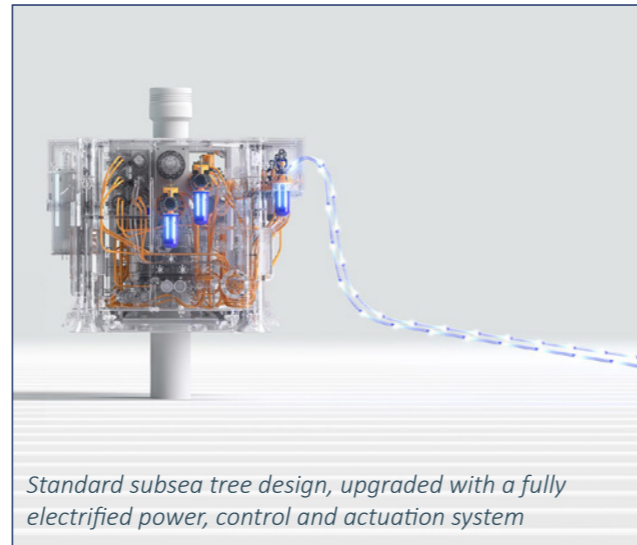
The project will fast-track wide-scale global adoption of electric subsea technology, setting new standards for increased operator control, subsea operational efficiency and reduced offshore emissions.

As part of the agreement, future engineering, procurement and construction will be directly awarded to SLB OneSubsea conditional on a final investment decision.

This project is the first application to be implemented resulting from a joint industry project, which commenced in 2018 and involved close collaboration across major industry players to accelerate the development of breakthrough electrification technology through a standardized industry solution.

Basing the design on an established standard enables efficient and economic scaling of subsea electrification for operators worldwide, bringing associated CAPEX and OPEX benefits.

The Fram Sør solution will use SLB OneSubsea's standard subsea tree design, upgraded with a fully electrified power, control and actuation system, while the elimination of high-pressure hydraulic systems will enable operators to go further and deeper, improving production and making even marginal fields more viable.



Standard subsea tree design, upgraded with a fully electrified power, control and actuation system



TSS RENTAL

Rental company NOR has added multiple TSS 350 systems to their equipment pool – the first rental company in Norway to own and offer the complete range of TSS HydroPACT systems from Teledyne Marine.

Manufactured at Teledyne Marine's modern research, development and manufacturing facility in Aberdeen, UK the HydroPACT range comprises the 440 & 660 pulse induction systems and 350 tone-based tracking system.

The 350 systems have been added due to client demand. Available for use in combination with a 440 or 660 unit or as a stand-alone solution, they provide additional options especially when seeking to find and track small diameter cables and/or identify cable breaks.

Typically mounted on a work class ROV the 350 is normally used in conjunction with a tone generator which propagates a tone down the line allowing the system to detect and track the location of the underwater cable. Where a break in continuity exists, the system can accurately pin point the location, aiding subsequent remediation or repair operations.

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Connecting What's Needed with What's Next™

AUTONOMOUS DEPLOYMENT

The Freedom™ AUV is the most advanced, resident-capable underwater vehicle, offering the data resolution and completeness of coverage in a single pass usually only obtainable using an ROV – but with the speed and mission efficiency of a traditional AUV.



 YEARS
1964 - 2024

■ Connect with what's next at oceanering.com/rov

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SUBSEA BATTERY

Kraken has received repeat orders totalling \$2.2 million for subsea batteries from existing Naval clients reaffirming their trust in our cutting-edge SeaPower batteries.

Rated for depths up to 6000m, Kraken's innovative subsea batteries provide up to twice the energy density and weigh 46% less per kWh than traditional pressure-housed batteries, making them the ideal choice for challenging underwater missions.

Kraken's subsea battery



EXAIL MCM

Exail has been selected to participate in the European Extended Mine Counter Measures (E=MCM) project. The objective of this consortium project, led by Naval Group Belgium, is to establish a future European sovereign capacity in mine warfare.

In response to the maritime mine threat and within the framework of the European Defense Fund, the European Commission is supporting European navies in enhancing their Mine Counter Measures capabilities.

The primary aim of the E=MCM project is to integrate new functionalities into the next-generation toolbox (toolbox 2.0).



Mine Counter Measures

These advancements are intended to effectively address the multifaceted threats posed by drifting, tethered, buried as well as the most modern mines.

Thanks to these new developments, the Toolbox 2.0 will go beyond the current new generation stand-off MCM Toolbox that Exail is developing and will be delivering as part of the replacement of the current MCM capabilities for the Belgian and Dutch navies.

ATLANTAS AWARD

Atlantis Marine has been recognised in the UK's most prestigious business award programme, being honoured with a King's Award for Enterprise for International Trade.

Founded in 2000, Atlantis Marine designs and manufactures underwater inspection cameras and equipment that enable marine inspections to be carried out using unmanned submersible vehicles controlled on the surface by specialist ROV operators.

It has been the UK dealer of industry-leading VideoRay ROVs since 2001, supplying in excess of 400 systems. It also provides subsea offshore inspection services, technical support and training to customers worldwide, working

across a range of industries including offshore wind, oil & gas and defence.

Atlantis Marine was recognised for its excellence in international trade, with the company's overseas earnings growing by more than 300 per cent over a three-year period. Its overseas turnover rose from 30 per cent of its total turnover to 51 per cent, with key export regions including Central and South America, Asia and Africa.

The King's Award for Enterprise will be presented to Atlantis Marine by His Majesty The King's personal representative in the county, the Lord Lieutenant of Somerset.

As a result of its recent growth,



Charlie Foll, Managing Director of Atlantis Marine and Mike Underwood, Head of Engineering
Atlantis Marine now employs 16 staff from its new state-of-the-art, energy efficient offices in Yeovil. With turnover in excess of £7million and expected to exceed £10million by 2027, the company plans to further expand its sales and inspection services over the coming years, particularly in the offshore wind sector.

REDUCE COSTS WITH BALMORAL INTEGRATED BUOYANCY SYSTEM

Balmoral INTEGRAL MODULE PLUS™

Our integrally clamped buoyancy module, type approved to API 17L, removes the need for a separate clamping system by attaching directly onto flowlines, rigid risers, umbilicals, flexible risers, etc.

- Rapid installation
- Minimised deck space requirement
- Lower shipping costs
- No separate clamping operation
- Optimal load distribution
- Lower through-life cost of ownership



Innovative **BUOYANCY, PROTECTION** and **INSULATION** product solutions for the **OFFSHORE ENERGY** sector

GREENSEA IQ /DPER CONSULTING PARTNERSHIP IN ISRAEL

Continuing to bolster its global market presence, Greensea IQ, a leading provider of marine robotics software and integrated solutions, proudly announces the appointment of DpeR Consulting as its international consulting firm representing Bayonet autonomous underwater ground vehicles (AUGVs) in Israel.

This partnership marks another milestone in Greensea IQ's ongoing global expansion efforts and underscores the company's commitment to delivering exceptional service and support to clients worldwide. With this expansion, Greensea IQ will extend its footprint into Israel, enhancing the accessibility of its advanced surf zone robotics solutions in this key region.

"We are thrilled to partner with DpeR Consulting," said Rob Howard, Greensea IQ's Chief Growth Officer. "Their expertise and deep understanding of the Israeli market make them an ideal partner to help us expand our reach and better serve our customers in the region."

DpeR Consulting brings a wealth of experience and specialized expertise, which will be instrumental in tailoring Greensea IQ's offerings to meet the unique needs of the Israeli market. Their regional knowledge and established network will be pivotal in fostering strong relationships with local customers and partners.

Founded with a focus on delivering innovative and efficient solutions, DpeR Consulting has a proven

track record in the marine and underwater technology sectors. As Greensea IQ's representative, DpeR Consulting will support sales and provide consultation, training, and support for the Bayonet AUGVs, driving Greensea IQ's growth and impact in Israel.

This new partnership with DpeR Consulting is part of Greensea IQ's broader strategy to build a robust global network of representatives.

By leveraging the expertise of local partners, Greensea IQ continues to advance its mission of developing intelligent ocean solutions and delivering unparalleled value to its customers worldwide.

KING'S AWARD

C-KORE

Serial Royal award winners C-Kore Systems have been honoured with a King's Award for Enterprise – International Trade 2024 due to their outstanding short-term growth in overseas sales over 3 years.

This is the company's third award in just over 5 years, having already received the Queen's Award for Enterprise – Innovation in 2019 and a Queen's Award for Enterprise – International Trade in 2021.

C-Kore has grown significantly since being awarded the Queen's Award for Enterprise- Innovation in 2019. The company has revolutionised the oil and gas industry with their small, automated, stand-alone testing tools.

Cynthia Pikaar, Director of Sales & Marketing for C-Kore commented "When we won our second award, The Queen's Award for Enterprise - International Trade in 2021, the business climate was very different.

"The world was going through a global pandemic and, due to strict quarantine rules, moving offshore personnel around for subsea operations was extremely difficult.

"Our customers really appreciated the benefits of our simple-to-use technology which negated the need for additional offshore personnel, whilst still having C-Kore technical support available remotely if required".

Fast forward 3 years and the reputation of C-Kore's patented testing tools has reached around the globe. With the assistance



C-Kore suite of tools

of strategically placed in-country representatives, attending local exhibitions, 1-2-1 meetings either in person or via Teams, and word of mouth recommendations from happy customers, C-Kore's overseas sales have continued to grow resulting in 80% of C-Kore's orders now coming from outside the UK.

As an organisation C-Kore is extremely proud of these achievements and is looking forward to continuing to serve the global subsea industry in the years to come.

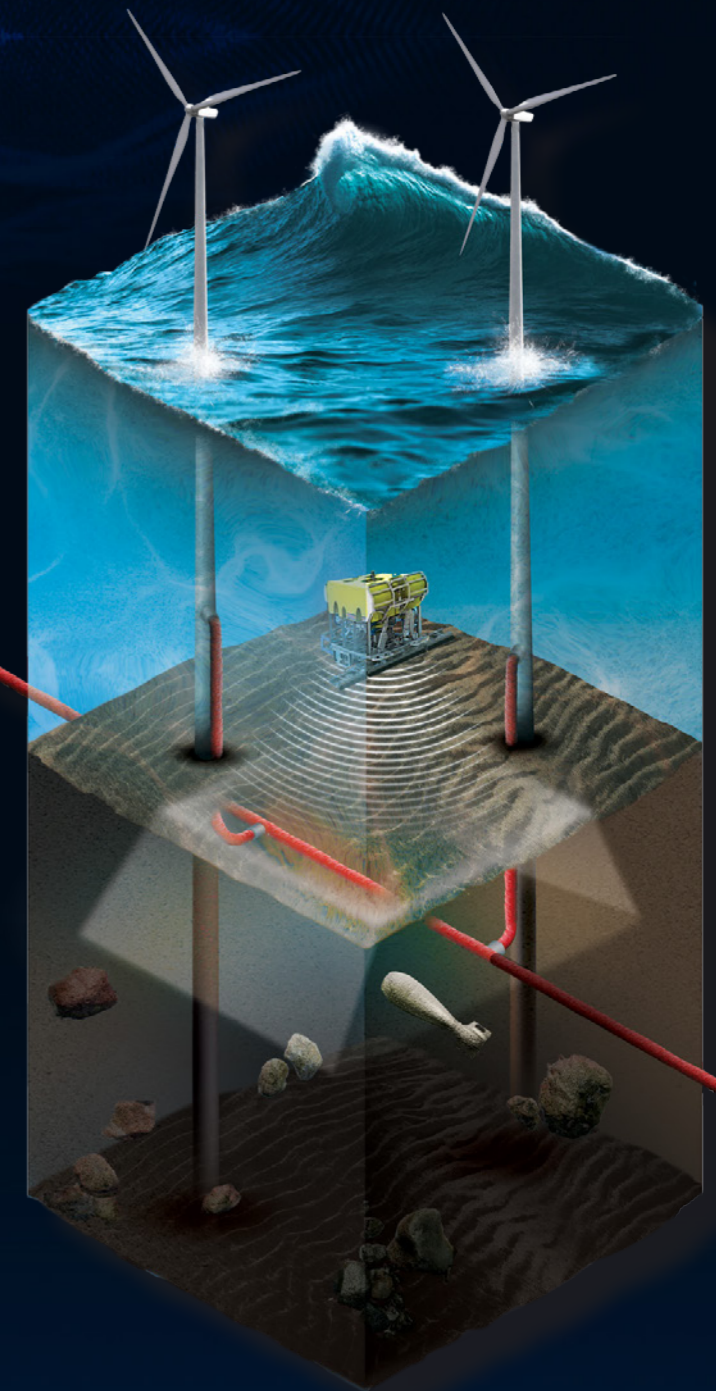
C-Kore will receive their award shortly and later in the year will celebrate with other winners at a reception being held at Windsor Castle.

● **Zetechtics** has been honoured with a King's Award for Enterprise for International Trade 2024 for Outstanding Continuous Growth in overseas sales over 6 years. The company is one of 252 organisations nationally to be recognised with a prestigious King's Award for Enterprise. This year, a total of 257 Awards were made, 161 of these for their contribution to International Trade.

Building on the success of the industry standard Jupiter Control Systems, Zetechtics offers a wide range of subsea control and intervention tooling solutions for high integrity applications across the subsea energy sector. The company has been trading since 1993, and is a previous Queen's Award for Enterprise winner, for Innovation in 2003.

CABLE, UXO & BURIED BOULDER SURVEYS FOR OFFSHORE WIND

Kraken's 3D acoustic route surveys are designed to provide wind farm developers, cable owners and cable installation contractors with the most detailed sub-seabed images available in the market.



Kraken Robotics | Underwater. Understood.™
www.krakenrobotics.com



SIMPLE TO USE!

Subsea Test Tools

INSULATION RESISTANCE • ELECTRICAL TDR • OPTICAL TDR • SUBSEA SENSORS

Save time & money on subsea testing operations. C-Kore's patented subsea testing tools are simple and automated, no specialised offshore personnel are required. With their compact size, they can quickly be mobilised anywhere in the world for fault finding, umbilical installation or sensor testing.

- ✔ Automated Testing
- ✔ Hand-carry mobilisation
- ✔ No personnel required
- ✔ Remote C-Kore support

Optical TDR version now available



Pre-piling template

SEATOOLS PRE-PILING TEMPLATE

Seatools has successfully delivered a pre-piling template equipment to CSBC-DEME Wind Engineering (CDWE) for the Hai Long Offshore Wind Farm project.

In close collaboration with CDWE, Seatools was responsible for the comprehensive design of the pile template's metrology and control system, encompassing all mechanical, electrical, hydraulic, and software components.

This scope also included hydraulic and mechanical systems dedicated to template levelling and precise pile positioning. The advanced metrology system ensures that pile installation is achieved with exceptional accuracy, meeting stringent tolerance requirements.

The commissioning of the equipment supplied by Seatools was notably smooth, due to utilisation of advanced simulation capabilities and to the constructive collaboration with CDWE through the different phases of the template design. These sophisticated simulations subjected the equipment to extensive virtual

testing under various operational conditions prior to its actual deployment.

This proactive approach significantly reduced the need for on-site modifications and calibration, streamlined the commissioning process, and improved the certainty of adhering to the offshore wind farm's construction schedule.

The accuracy and reliability demonstrated through these simulations reflect Seatools' dedication to employing technology for superior project performance.

The project uses both a vibratory hammer and an impact hammer for pile installation. This mixed-method approach led Seatools to undertake a detailed evaluation, ensuring the equipment's structural integrity and operational reliability under the varied loads imposed by both the vibratory and impact methods.

Seatools says that milestone reinforces Seatools' standing as a leader in advanced subsea metrology and control solutions.

BALMORAL COMTEC

Balmoral Comtec, a major provider of buoyancy, protection and insulation services to the global offshore energy market, has been awarded a multi-million-pound contract for the supply of 400 cable protection systems (CPS) by Ørsted for its Hornsea 3 project, located 120km off the Norfolk coast.

The scope of work includes design engineering which will take place at Balmoral Comtec's Aberdeen facility, supply of 400 cable protection systems, and handling and installation training to the awarded marine contractor.

Managing the challenges of over-bending, abrasion and fatigue of underwater cables can be an ongoing challenge for offshore wind developers. Balmoral Comtec's patented system utilises validated materials designed to improve operational performance and increase fatigue life. The patented system mechanically locks together removing a reliance on PU bonding, which is notoriously unpredictable and problematic to validate over field design life while providing market-leading strain and stiffness levels that cannot be achieved by traditional CPS designs.

C-Kore
Simplify Subsea Testing



GREENLINK AT PACWAVE SOUTH

MacArtney's GreenLink terminations will connect innovative technology at PacWave South. This cutting-edge platform, run by Oregon State University, is for testing and optimising marine energy devices in open-ocean environments, driving the application of wave energy as a reliable power source.

Through PacWave South (PWS), a full-scale test facility featuring four offshore test berths, Oregon State University (OSU) provides the necessary infrastructure for U.S. and international wave energy innovators to feed the electricity grid with alternative power sources.

The project received significant investment from the U.S. Department of Energy to support the development of carbon-free wave energy conversion (WEC) technologies. PWS covers an area of 2 square nautical miles and is licensed to support testing up to 20 commercial-scale WECs.

To ensure reliable grid connectivity from each berth to the shore-based facility, OSU and its selected prime marine contractor for the system manufacture, delivery and installation, RT Casey, collaborated with MacArtney to choose the proven GreenLink dry-mate solution. This will terminate the four dedicated PWS subsea power and fibre optic cables and connect client-supplied dynamic cables or umbilicals.



MacArtney's GreenLink terminations will connect innovative technology at PacWave South

SCOPE OF SUPPLY

MacArtney supplies five half GreenLink terminations for the four power transmission cables, including the termination work; four are allocated to the test site and one to mate and test them.

MacArtney technicians will help install and test the GreenLink terminations onsite at cable supplier NEXANS, Norway, a world leader in offshore control and high-voltage submarine cable systems. RT Casey will be overseeing the installation and testing of the GreenLink terminations onto the subsea cable in Norway at the cable factory, transportation of cable and connectors to Oregon, and the safe subsea installation of GreenLink from their cable installation vessel to the sea floor for future system connectivity.

ADVANCING MARINE ENERGY INNOVATION

MacArtney's GreenLink range is designed for fast and flexible connectivity, making it ideal for

the grid-connected PWS facility. The solution efficiently transfers its total potential power output of up to 20 megawatts (MW) from the berths back to the land-based electricity grid.

Furthermore, MacArtney's solution is scalable, making it attractive for both large commercial floating wind parks and small-scale systems.

REWARDING LONG-TERM RELATIONSHIP

MacArtney provided OSU with invaluable technical advice on connectivity solutions during the conceptual design phase of PWS, which started in 2012. Recognising that MacArtney had a proven connector that was well suited for the conditions, RT Casey opted for MacArtney's GreenLink solution for PWS, which includes MacArtney's extensive knowledge and expertise about the renewable energy sector compared to local suppliers who may need more experience in this specialised field.

MacArtney's GreenLink range is designed for fast *and flexible connectivity*

VALEPORT

Bathy2

The latest evolution in bathymetric measurement



Density corrected depth data directly from one instrument.

The Bathy2 is an enhancement of the MIDAS Bathypack offering Valeport's proven survey industry standard sensors to generate precision Sound Velocity and Density profiles for highly accurate depth and height data.

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+44 1803 869292 | www.valeport.co.uk

UT2 100

The Offshore Technology Conference in Houston is an annual feature of exhibition diaries, often resulting in far-ranging business deals. Eighteen years ago, a conversation with the SUT's then Chief Executive, Ian Gallett was responsible for the launch of UT2.

The magazine has now reached its 100th edition.

John Howes, UT2 Editor, writes
"Having covered the offshore industry for decades, I became very interested in starting up my own magazine. This idea resonated with Ian who saw the value for the SUT in having a media vehicle that could provide contact with its members and generally promote underwater technology to a wider audience.

"We tentatively considered aspects of what eventually proved to be a useful symbiotic relationship. I would essentially produce an entire technical colour magazine, be responsible for editing and publishing and bearing the start up, printing and running costs but benefit from any future profits. Either side could pull away at any time.

"Ian approached the SUT council. Not without resistance, he successfully steered the proposal through and I commenced planning the first issue.

"*But what to call it?* The SUT already had a well-respected technical peer reviewed publication called *Underwater Technology*. I reasoned that the new colour magazine would be lighter, more commercial and dynamic. I proposed simply using the capital letters UT as a nod to the



Inaugural Issue

existing SUT publication. It wasn't until quite an advanced stage that a doctor friend said in passing that UT is often employed as an abbreviation for urinary tract. I put a squiggle next to the UT as a reminder to change it. In a draft, that squiggle was interpreted at the printers as a two and the title UT2 was born.

"The magazine was to be free to SUT members and others, and rely on advertising. But who would advertise in a magazine that nobody has seen before? This is exactly why it is only large publishing houses with deep pockets that launch magazines. This was where the SUT came to the rescue.

"Some companies such as Total, ABS, Kongsberg, Kystdesign, Fugro, Acergy, All Oceans, SRD and Chevron took the leap of faith and supported the venture. After the issue, I wanted to go to Aberdeen to introduce the magazine but the printing had wiped me out and I was not able to afford the hotel and air fare.

"Within a year, however, companies such as Schilling, Nexans, FMC, Applied Acoustics, Subsea 7, Seaeye, SMD, Videoray, Tritech, Aker Kvaerner Seabotix, Atlantas Marine, Reson, Gavia, EMGS, MacArtney, Valeport and Cameron came in to support the magazine and it looked as though I could expand the magazine and pay off debts. It lasted for a few issues and then came the fall in oil price.

"Over the journey, we have ridden out many price falls, enjoying considerably more good times than bad and providing thousands of pages of original editorial.

"We put the magazine online. Nowadays, everyone does this but UT2 was one of the very first magazines to use 'page turning' software to view an online version of the magazine.

"In 2017, Zinat Hassan joined UT2, to look after the advertising and commercial side. This released me to launch a sister magazine Underwater Robotics which is dedicated to subsea vehicles of all types.

"What will be in the next chapter? Magazine publishing has changed but we are already planning ways to reinvent ourselves."



Past executives Bob Allwood and Ian Gallett

EMPOWERING

World leading electric underwater robotics

Seaeye eM1-7

Electric Manipulator

- Seven function work class manipulator
- Compatible with most work class ROVs
- Maximum reach 1,990mm
- Lift capacity 122kg/454kg (max/min reach)
- Precise position and force feedback
- Modular self-contained joints
- Wrist camera option
- Diagnostic power and status LEDs
- Interchangeable parallel and intermeshing jaw options
- On-board processing for advanced kinematics

saabseaeye.com



SAAB



BIRNS 70

BIRNS, the high-performance underwater connector and cable assembly designer/manufacturer is celebrating its 70th birthday. On a visit to London, the company discussed some of the technology it has been developing recently.

"We introduced the BIRNS Meridian series, a new line of high ampacity connectors at Oceanology," said Bruce Meredith, Technical Sales Manager.

"We have been providing high voltage connectors for many years, but have noted that enquiries for high current or ampacity connectors has risen recently."

BIRNS Meridian connectors are 225 Amps and 6km-rated, and are ideal for devices that have a high amperage power transfer requirement associated with them, such as battery packs and thrusters for crewed and uncrewed subsea vehicles.

"As battery systems are getting increasingly more advanced and thrusters are getting larger to allow vehicles greater speeds and depths, the demand for current capacity has also increased."



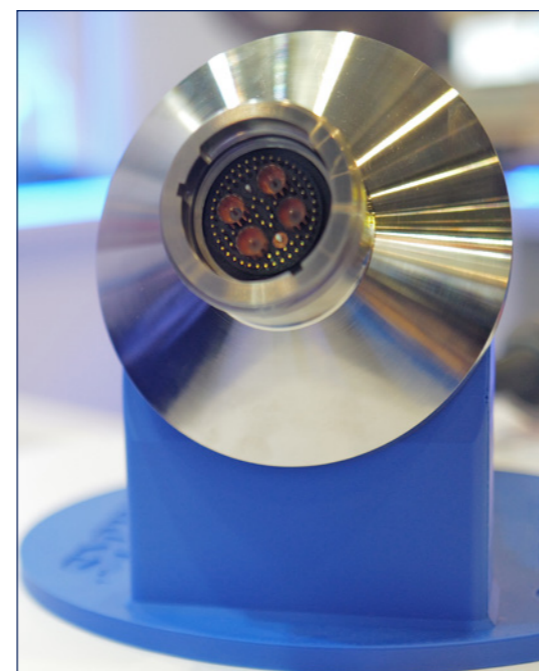
6000M Open Face Rated COAX Cable Assemblies

Select sizes are presently being DNV type-approved for 6km rated crewed submersibles. BIRNS Meridians are compact and feature 4 pin configurations, with more currently in development.

"A unique feature of such connectors is the very large pin diameters, for example, the M40 has a single 85 mm² (3/0 AWG) contact," said Meredith

BIRNS Meridian M40-1 Titanium Connector Pair

"Both standard and reverse gender versions are featured in the series and all withstand reverse pressure. They can be installed into both dry and oil-filled canisters.



Hull penetrator face



C-KORE 800



Military-grade penetrator

6000M

"Our connector lines are all open face pressure rated to 6km. The exception for open face rating historically, for ours and others in the industry, were coaxial connectors.

"However, with recent testing, we've certified that both our 50 and 75 ohm coax connectors are rated to open face at 6000m depth, which is unheard of in the industry. Our BIRNS Millennium series 1C assemblies also achieve a remarkable -0.35dB attenuation and 1.2 VSWR at 3GHz. Low losses, high frequencies, and 6km open face pressure resistance—we feel that these performance characteristics are invaluable to our customers.

HULL PENETRATORS

"Another recent introduction is military grade hull penetrators for submarines, which we designed in response to a recent customer request. One challenging design aspect of a recent configuration was that the small receptacle not only contained 67 electrical contacts, but four coax connectors and two fibre optic lines, all within a sub-safe housing. Here at Oceanology we are excited to also launch new 6000 meter-rated DNV type approved penetrators for some major new contracts."



Automated subsea testing tools specialist C-Kore Systems is celebrating the mobilisation of their 800th unit. The job is with a major operator off the W African coast for fault-finding operation on a complex subsea electrical network.

C-Kore has been assisting operators worldwide for over a decade with more than 300 subsea faults found so far! Its subsea testing units have gained worldwide acceptance with both operators and contractors for the cost-savings the tools provide, the reduction in offshore personnel required for testing, and the simplification they bring to subsea operations.

To date, C-Kore's testing tools have been used on over 100 different fields by more than 80 different customers around the world in 23 different countries. With over 35,000 tests being run, it can safely be said that C-Kore Systems has a good understanding of subsea fault-finding.

After completing their offshore campaign, the Subsea Controls Engineer at a major operator commented, "We managed to locate another line fault in the system resulting in a EFL changeout and subsequent restoration of IR health."

OCEANEERING @ 60

With Oceaneering turning 60 this year, co-founder Mike Hughes mused upon the early days to the company.

"The company effectively started due to an insurance issue," said Hughes. "In order to work for an oil company, a diver requires some sort of insurance. We were quoted \$2000 for a down payment on the initial premium. Five of us found \$400, bought the policy and formed Worldwide Divers working out of a rent house in Bayou Vista, each owning a 20% share.

"I told everybody that they can each take 20% or I can run the business, do the payroll etc, but as this would keep me from diving, I would require 40% with everybody else taking 15%. This was preferable to them as we all had our own equipment. There was not a lot of investment in the company and none of us thought shares or interest in the company would amount to much anyway.

"At the time, Union Carbide Corporation had bought a diving company named Ocean Systems. They were funding mixed gas research and decompression technology. They also looked to hire the best divers.

"Divers were paid a depth premium and with this temptation of Ocean Systems capturing a lot of deep work, they lured away three of our guys, leaving only Johnny Johnson and myself as remaining partners.

"Business grew to a point where I couldn't handle the

work all by myself, so with just the two of us we revised the management. His 15% would rise to 49% while my 40% would rise to 51%. In 1969, we merged WorldWide Divers with California Divers (Cal Dive) and then with Vancouver-based Can Dive.

"We were consistently being asked to go deeper. Even when I started diving in the Gulf of Mexico, nobody was diving commercially with SCUBA gear because we needed communications with the surface. If we had a wire, we might as well have a hose which gives the advantage that you can stay down pretty continuously if you're working at a shallow depth.

"One of the things that ex-Can Dive's Phil Nuytten proposed, which I had never thought about and I'm sure no one else in there had, was the development of a capable one-atmosphere diving suit.

The idea of a one-atmosphere diving suit would be a huge breakthrough because there would be no more need for decompression. We incorporated this into our portfolio



Oceaneering's Millennium ROV at the National Buoyancy Laboratory



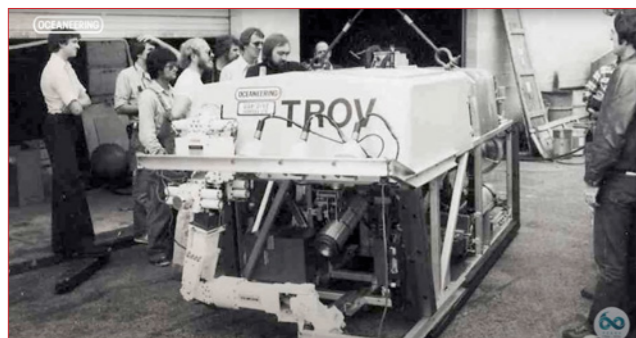
This is an excerpt from an interview by Bill Mallin VP Global Marketing and Communications. The full interview is available from the oceaneering.com/60-year



A new vehicle to search all environments safely and quickly...
JW Fishers SeaLion-3 ROV

- Front & rear HD cameras standard
- 7 thruster, vectored system
- 15.6" LCD display monitor
- 12.1" LCD touchscreen Control Monitor
- Speeds up to 3.5 knots
- Operating depth of 1,000' (305m)
- Commercial grade design



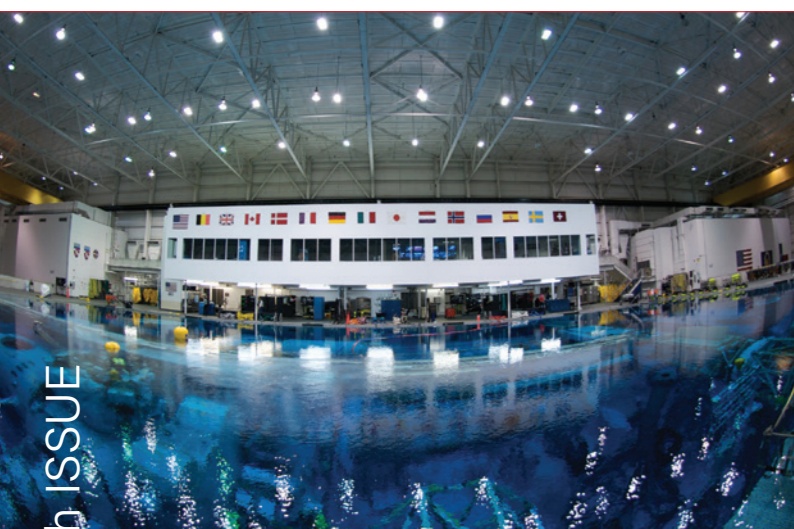


The TROV, one of the first workclass ROVs

This had its limitations. As water depths continued to increase, it became necessary to look at the new remotely operated vehicles that were being funded by the US Navy.

All these could do were observe – they could not perform any tasks– but they looked very interesting. Oceaneering acquired Ocean Systems who had already started developing some technology.

Since these early days, Oceaneering has expanded into Umbilicals, Leisure and even Space as the experience of astronauts has very similar parallels with working underwater. Our divers now train astronauts in the Neutral Buoyancy Lab at NASA's Johnson Space Center and designed and produced that toolkit for the Hubble telescope.



Neutral Buoyancy Laboratory

25 YEARS FOR OISL

Oceaneering 's wholly-owned subsidiary, Oceaneering International Services Limited (OISL), is celebrating the 25th anniversary of its operations at the Port of Rosyth. OISL provides operational and manufacturing support to the U.K., Europe, Africa, and the Middle East.

The company was originally based in the Port of Leith but became one of the first tenants to occupy the Port of Rosyth when it was established in 1999.

The Port of Rosyth is home to Oceaneering's U.K. umbilical manufacturing facility. The site is equipped with state-of-the-art manufacturing capabilities and produces subsea umbilicals and hardware to meet diverse customer specifications.

The Rosyth site is also home to Oceaneering's Testing, Qualification, and Reliability Laboratory, a purpose-built facility designed to meet the requirements for topside and subsea component and assembly qualification and factory acceptance testing.

Earlier this year, the Rosyth facility achieved 'Fit 4 Offshore Renewables' Granted Status from the Offshore Wind Energy Council and ORE (Offshore Renewable Energy) Catapult.



Oceaneering's Umbilical facility in Rosyth

THE ULTRA HIGH RESOLUTION SONAR COMPANY

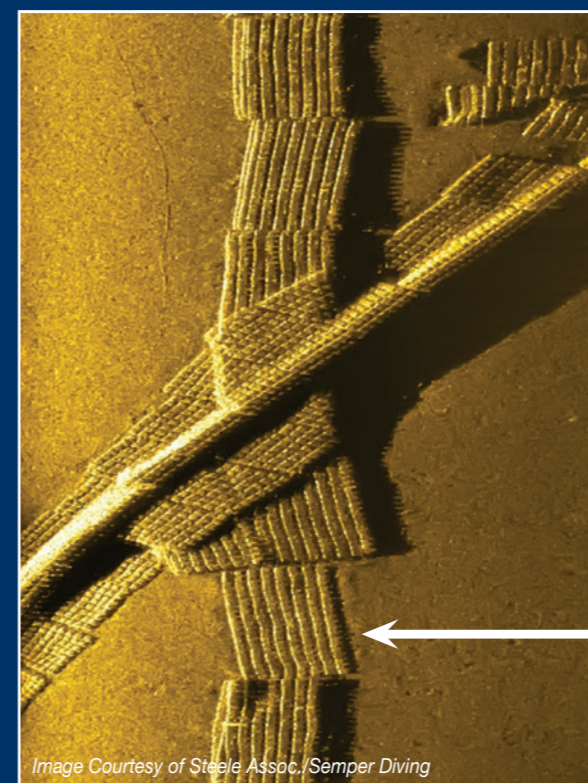


Image Courtesy of Steele Assoc./Semper Diving



Concrete Mat Installation

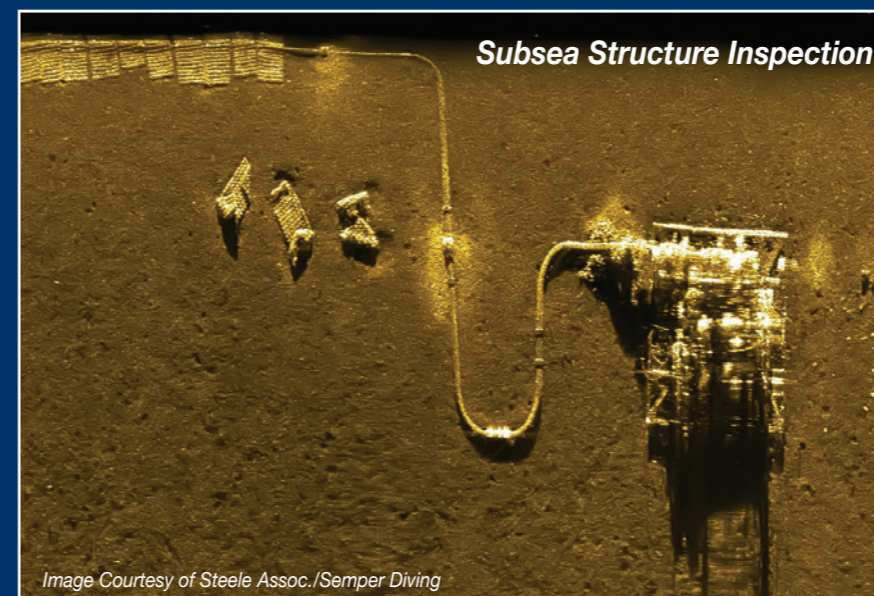


Image Courtesy of Steele Assoc./Semper Diving

Subsea Structure Inspection

- Tri-frequency options give long-range capability and high resolution classification
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- EdgeTech is the first manufacturer of commercial Side Scan Sonar Systems and the technology leader since 1967
- 24-Hour support from the world's most experienced Customer Service Team

DRiX O-16

Exail is to launch the game-changing DriX O-16, which it has designed for long-duration operations (up to 30 days). Twice the length of the earlier DriX models, it will be large enough to deploy multiple payloads and subsea assets. This revolutionary Uncrewed Surface Vehicle (USV) is based on seven years experience operating the original ground-breaking DeiX design.

The new DriX O-16 is especially suited for advanced scientific and hydrographic surveys, geophysical and UXO surveys, as well as subsea infrastructures inspection and surveys that might require the deployment of multiple robots.

Back in 2017, the then iXblue disrupted the world of offshore survey with the launch of its sleek DriX uncrewed surface vehicle. Since then, this vehicle has accumulated over 150 000hrs of operations at sea, travelling 2500 Nm in more than 19 countries. This represents 40 times the round globe.

With the length of 7.71m and its 1.6t displacement, it could sail around for up to 10 days at speed of 14 kt. Its 250L fuel tank gave it a range of 1000 nautical miles.

This vehicle was later called the DriX H8 to differentiate it the newer and upgraded DriX H9.

The DriX H9 vehicle was about a metre longer which allowed it to carry more fuel and this gave it a greater range. The capacity increased from 250L to 550L and



in doing so, essentially doubled the endurance from 10 up to 20 days.

The latest generation vehicle, called the DriX O-16 is set to change the market again.

DRiX O-16

"The length of the new vehicle has increased from 5.71 to 15.75m, twice as long as the very first DriX," said Olivier Cervantes, VP Maritime Autonomy Solutions at Exail. "By doubling the length, the volume has increased by around 10 times. In doing so, the displacement has increased from 1.6t in the H8, up to 10.5 t.

"The vehicle is also a revolution in terms of endurance. All this extra capacity allows the vehicle to work

up to 30 days at a time with the range increasing to 2500 nautical miles."

Back in the original H-8 design, the top-heavy vessel was balanced by a retractable gondola which could house instruments. In the H-9, this turned into a larger structure. In the new vehicle, the gondola is a n extended permanent structure, 26m long, with a capacity to install 2.5 t of equipment.

"This now has room for a number of

deep-water, sub-Bottom profilers and acoustic subsea positioning and communication systems (USBL)," said Cervantes.

"While previous vehicles permitted a Multibeam Echosounder (MBES), with a capacity to scan 3000m, the new DriX is enough to accommodate the very large echosounder antennas, required for multibeam imaging down to full ocean depth.

"Another feature of the previous vehicles was they afforded an ideal platform to tow Exail's FlipiX ROTV. With its with active motion control (depth/altitude, pitch, roll), the FlipiX can carry Side Scan Sonar and magnetometers as well as providing interfaces for other type of sensors to increase the value of the DriX survey.

"As well as the ROTV, the back deck of the DriX O-16 is now large enough to launch and recover subsea assets such inspection-class Remotely Operated Vehicles (ROVs) as well as Autonomous Underwater Vehicles (AUVs).The deck has a one-ton capacity, so we could fit a range of equipment. It's truly redundant.

"At the front is an AI powered forward-looking sonar. This can scan

the water column to avoid obstacles such as fishing nets. The control system can combine all underwater information with radar, cameras and Lidar information for a total sensory package."

The new vehicle retains its diesel proportion system, but in addition, it has additional electrical system. This gives the DriX O-16 a greater speed, but the hybrid arrangement also means that the power source is dually redundant and thus offers a high level of reliability and operational efficiency.

"The diesel system is still located at the stern but forward from this, the new electric pod can rotate 360," said Cervantes. " There is also a bow thruster, so that instead of previous design to the vehicle being able to

hover, the O-16 has dynamic positioning. Being able to stay at one point without moving can be essential when launching and recovering assets

"This vehicle will be available late this year. It should be in the water in a couple of months and we are planning our first demonstration mid year with the target of launching of September. It will have a 12 month delivery time.

"With this next-generation transoceanic low-carbon USV, we are pushing back the limits of ocean exploration, empowering collaborative autonomy between surface and subsea drones, while minimising human exposure at sea," said Cervantes.

"The introduction of our new DriX O-16 truly marks a significant stride in autonomous maritime operations. Multi-robot missions are definitely where we see the maritime industry and our own developments leaning in the coming years."

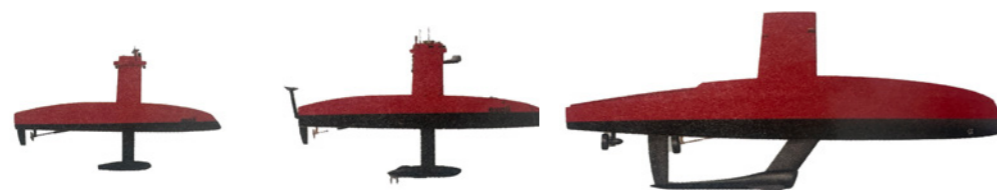
DRiX O-25



DriX O-25

While the three DriX vehicles will be production models, Exail are also looking at the possibility of producing a Larger custom-made vehicle. It will be 25m long and displace 80t. It will have similar speed and endurance to the production versions but the larger body will give it a fuel capacity of 20,00 L.

One of the principal features is that it will be able to launch and recover large AUVs able to operate at 6000 m. This DP2 uncrewed vessel will therefore, extend the range of the underwater vehicles while providing surface support.



	DriX H-8	DriX H-8	DriX O-16
Length	7,71 m	9 m	15,75 m
Displacement	1,6 t	2.1t	10,5t
Endurance	< 10 days	<20 days	<30 days
Speed	< 14 kts	< 13 kts	< 13 kts
Fuel capacity	250 L	550 L	2300 L dual hybrid
Range	1,000 nm	2,000 nm	2500 nm
Communications	Wifi, 4G, Satellite communication, UHF radio		
Towing/LARS	ROTVs towing capabilities		
Stationkeeping	Hovering	Hovering	DP
MBES capacity	3,000 m depth	3,000 m depth	Full Ocean
Transportation	1x 40' High Cube container		

Ocean Power

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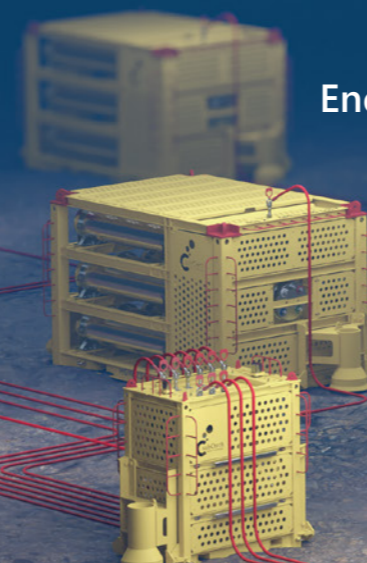
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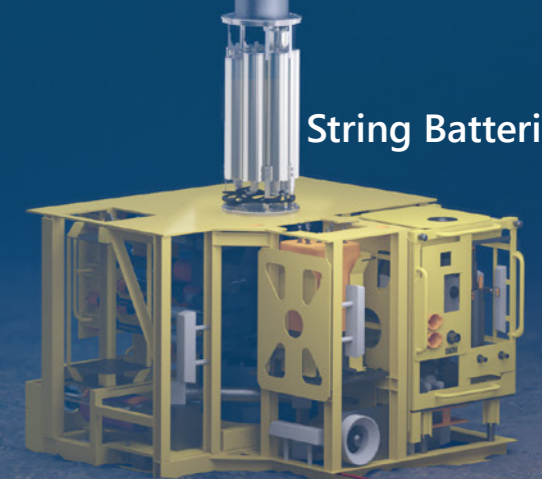
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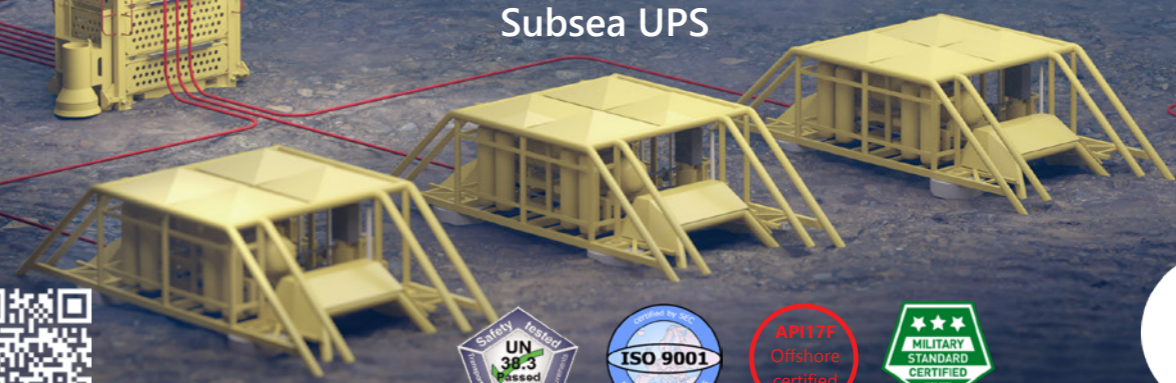
Vehicle Batteries



Energy Storage Systems



String Batteries



Subsea UPS



FLY CUDAJET

Cudajet is a back-mounted propulsion system, allowing the user to fly through the water and steering by just moving the body. It has applications from leisure to the military or possibly used in association with an ROV.

"I was looking to design something that went as fast as possible but had high manoeuvrability," said Archie O'Brian, CEO of Cudajet.

"All the devices on the market are designed for long endurance and are very quiet, and there are very understandable applications for these, but none were able to turn quickly or have a hands-free control. This has leisure market applications but there may be military applications where the diver needs to get out of somewhere fast.

"At the prototype stage, the idea was to buy-in the necessary components and assemble it in-house but this didn't work out because we didn't find components small or light enough to fit into the package we envisaged. I ended up having to design some parts but by the end, we had engineered most of the components from scratch including the entire power train and casing.

"The Cudajet is around 12.5kg but produces 40kg of thrust. It is possible to travel up to 3 miles/sec in water and travel at 40m under water. We can extend this to 100 metres if a client really requires this. Increasing the depth would make the jet marginally heavier - maybe 100g or 200g but in the design, we have endeavoured to shave weight off when at all possible. In order to

further minimise weight, we considered making it neutrally buoyant but there is little room to add flotation without increasing the size, so we just went for the smallest lightest envelope we could.

"Many propulsion systems are rigid and the user is either towed or the user lies on a board or flat surface. Our system is designed to be positioned between the shoulder blades which that allows the user to flex their body and move normally and in doing so, steer the system.

"That is where the harness comes in play. We designed it in-house from raw materials, a mixture of composite materials and foam with the fabrics. It holds the Cudajet firmly on the users back at the correct angle and cope with the sudden accelerations. We have fitted in the harness so the user can sit in the water comfortably. There are no leg straps because we didn't feel the leisure market would allow it.

"It is possible to come running out of the water with the pack on but also run into the water as well as dive off rocks and cliffs.

The Cudajet is similar to a principle to a Hamilton water jet system. Water enters the front and an impeller speeds it up and the jet exits from the back. In this design, it splits into two sides, which gives more stability in the water, but this assists in turning very fast.

With a smaller package comes with



the downside of a lower duration but even so, it can last for durations sufficient for most requirements.

"We say average, it can last for 40 minutes, and people are normally pleasantly surprised," said O'Brian.

"It depends on what the user is doing in between divers, eg, if the diver is travelling in straight lines and how fast they want to go because power usage is exponentially proportional to the speed. The faster it goes, the more power is required but even a 70% power drop, you can go a decent speed for considerably longer.

When the battery is exhausted, it is possible to unclip the housing and insert a fresh one. The battery itself can be recharged in around 75 mins. For the leisure our market, we need plus 500 lifecycles before losing 20% capacity, but if you only need 100 lifecycles for a product at this price, we could charge it in 30 minutes a week.

We have been speaking to a couple of ROV manufacturers, not so much as using a derived system to supercharge the movement of a vehicle but for when a diver and ROV works in tandem. The divers can get to the site faster and move at the speed of the vehicle.

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3D MINI SONAR

Water Linked has developed an innovative mini-3D sonar. Called the Sonar 3D-15, it is light and compact enough to be installed on small underwater vehicles to produce a clear three-dimensional acoustic image while also being a useful tool for larger vehicles. This image confers a more intuitive navigation, greatly enhancing the user's capability to manoeuvre around obstacles and pinpoint targets.

Shallow waters are often characterised by high turbidity flow which may render optical cameras ineffective. Traditional 2D sonars offer notable improvements but often fail to provide a comprehensive understanding of the whole surrounding environment.

"Piloting a small vehicle is often assisted by 2D imaging – typically mechanical scanning sonars or 2D multi-beams," said Scott McLay, Chief Commercial Officer at Water Linked.

"Pilots can only make decisions based on what they believe is in front of them, however, and interpreting 2D images relies on the operator's skill.

"Having more information allows better decisions. One upgrade is employing 3D sonar which not only makes navigation considerably easier, but helps operations, especially when manipulators need to interact with a target.

"3D Sonar can be found on some large, more powerful underwater ROVs, but until now, because of their size and mass, are unavailable to smaller vehicles.

"From the start of the company, we recognised that smaller vehicles would represent a growing proportion of the future subsea market. If companies use small vehicles, it is axiomatic that they will look for small sensors. We, therefore, set ourselves the challenge of making sensors full-functioning but as small as possible.

In 2020, Water Linked brought out a DVL that was so small, that it could be even put on micro-ROVs and that made a big impact in the market.

"A lot of the lessons learned from the DVL has gone into the 3D sonar design," said McLay. "We researched various ways of making it very robust and this technology has been applied to the development of the new sonar. Another thing we learnt was how to deal with extraneous noise. The fact is, however, that the 3D Sonar development represents a completely different level of complexity compared to the DVL.

SENSOR DESIGN

"A critical question that has to be faced when developing such sensors, is identifying the optimum size weight and power.

"If the engineers wish to make a long range sonar, this will require a physically larger sensor. This in turn will probably need to be powered by higher voltages and this in turn makes it limited to large vehicles with more available power through larger umbilicals or bigger batteries.

If the Sonar is larger, it's also likely to be heavier and all this means a larger vehicle.

"Conversely, if we are going to make the sensor suitable for small vehicles, the first thing we need to do is to determine the maximum size and power limits, and then understand what we can achieve using these.

"Another factor that has an important bearing is the eventual price. Generally, the bigger something is the more it costs, but this is also sometimes true when trying to miniaturise something. In this case, however, the cost has been as low as possible to open up the market for a bigger market share."

DATA

Maybe only to 15 years ago, a Sonar would receive signals and transfer this data up to a topside computer where the processing would be carried out. At the time, there was no space to fit processing systems on the sonar itself. This all changed with advances in microchip technology allowing more processing to be carried out in the sonar itself and less on the vessel.

"The advances in microprocessors are continuing and even by the time are shipping this product in the market, there will be a new processor that will be processing data even faster," said McLay. "You then have to decide, whether to go forward utilising the latest technology that's available, or continually delay, waiting for the latest and greatest to come to the market?"

"There's a lot more processing carried out in 3D than there is in a 2D Sonar so the increase in 'number crunching' requires greater processing. This, in turn, requires

space within the body of the sonar.

"All things being equal, the greater the amount of processing, the larger the package necessary to contain it and the greater the mass. As we try to reduce the dimensions of the Sonar, we have to make a judgement call about the optimum size.

"The available chipsets we have are reliable and proven and so, therefore, we have selected systems carefully, pushing the risk/performance envelope as far as we're prepared.

"The amount of processing means that the Sonar can be very hot. Fortunately, when used subsea, the water helps the heat to dissipate but when the sonar is on deck, if it can't be easily switched off, it will eventually overheat.

"As with the DVL, we have incorporated thermal protection into the design and also utilized a Stainless Steel backplate. Titanium and other materials were considered for the housing, however stainless steel is far better for heat dissipation.

"Many companies look at competitors' sensors or devices and build their versions to compete in the market. Our new Sonar, however, is not a copy of something else.

"There are other 3D sonars out there but they are completely different and not suitable for the latest generation of micro vehicles.



At present, we have a fully developed working system. Our next task is to take all the code that's already been written for image processing and move it over it into the sensor itself. Realistically, this will probably take us a number of months. During this time we will streamline the production process.

"We are now building the hardware and estimate that the shipment date will probably be in the third or fourth quarter of this year.

"The benefit of the way we've done it is that because we've got the hardware done, we've got time to

work on the front end and the GUI. The user interface will be based on customer feedback. We want to ensure that the protocols we output will be something that they can easily use

"We believe this will reset the standard to be 3D instead of 2D and companies will have to respond to this. It is game changing. At present, the range is limited to about 15m but I suspect we will develop future generation with larger ranges and greater working depth."

Dimensions	w12 h8 d4	Input voltage	10-30 Vdc
Weight in air	0.9 kg	Power	20 W (maximum 60W surge)
Weight in water	0.5 kg	Power (standby)	3 W
Depth rating	300 m	Physical interface	3-m cable
Material	Stainless Steel 316 Polyurethane	Communication	Ethernet
Temperature	-5 to 55 °C	Bandwidth	10 Mbit/s
		Protocols	Water Linked API
	Navigation	Inspection	
Transducer frequency	1.2 MHz		2.4 MHz
Horizontal field of view	90° (±45°)		40° (±20°)
Vertical field of view	40° (±20°)		40° (±20°)
Maximum range	15 meters		4 meters
Minimum range	20 cm		20 cm
Range resolution	4 mm		1.5 mm
Beam separation	0.35° (horiz) / 0.6° (vert)		0.16° (horiz) / 0.6° (vert)
Angular resolution	0.6° (horiz) / 2.4° (vert)		0.4° (horiz) / 1.1° (vert)
Update rate	5 Hz		20 Hz

PROFILING SONAR

In what seems like a regular occurrence, Impact Subsea has launched a new sonar system. Needless to say, it is one of the smallest on the market.

Many years ago, when Ben Grant started Impact Subsea, he recognised that there would be considerable advantages in developing sonars with the smallest possible weight and footprint.

It now incorporates some of the world's smallest imaging sonars both at entry-level and larger, more powerful HD versions.

For the next stage, the company decided expand the range to include all aspects from navigation, obstacle avoidance and imaging, and saw that a profiling sonar would fill a gap in the product range. The result was the ISP360.

"Our new ISP360 profiling sonar emits a very fine 1 deg conical beam, which sweeps to create a perfect slice around it to produce a basic single range measurement," said Ben Grant. "As the profile is moving continuously, it creates additional points and these can be

used to build up a 3-D point cloud. Combining the data set, produces imagery around the line."

Such a sonar is very useful in applications such as a pipeline survey to check for free spans—gaps Washed away underneath the pipeline where the structure is left unsupported

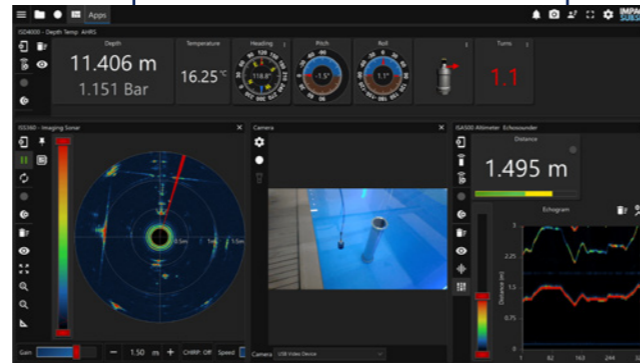
"The advantage with our profiling solar is that it is small than therefore not particularly power hungry," said Grant. "It's lightweight also means that opens up the market for use on smaller. ROVs and eve AUVs.

"When it is running at the higher frequency, it emits its one degree conical beam and this ensonifies structures up to 40m away, but if the frequency is reduced, this widens the beam angle to 2° and it is possible to detect structures up to 80m away.

"The ISP360, therefore, has the flexibility for shorter range, higher resolution profiling, but can also work at longer ranges."

seaView

Impact Subsea recently announced the release of seaView 3.1, a significant update to their popular operation, configuration and logging software suite. seaView 3.1 empowers users with a range of new features designed to enhance efficiency and streamline subsea operations.



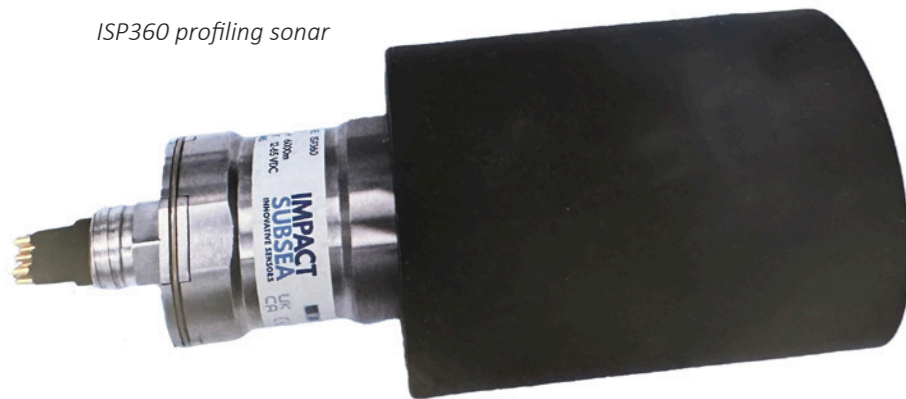
seaView 3.1 operation, configuration and logging software suite.

A major highlight is the introduction of video support. Users can now directly view and record video streams from any connected video camera within the software.

This allows for a unified view of critical data, including video, sonar, altitude, depth, temperature, heading, pitch, and roll, all presented in a single, user-friendly interface.

seaView 3.1 introduces a powerful global logging and replay functionality. This feature enables users to record data from multiple sensors simultaneously into a single file. The recorded data can then be conveniently replayed within seaView, ensuring all sensor readings remain synchronised for in-depth analysis.

ISP360 profiling sonar



'YUCO' micro AUV

CARRIER



SCAN



CTD



PHYSICO



PAM



easy to use

payload options

ultra compact

think  pink



SEABER available in the UK & Ireland from



PHINS ON EELUME S SERIES

Norwegian company Eelume, known for its M-series of modular Autonomous Underwater Vehicle (AUV) vehicles, has recently introduced the S-series. This comprises a range of small to medium-class All-Terrain vehicles engineered to operate in close proximity to challenging underwater topographies.

In addition to carrying out conventional AUV applications, Eelume's designers say that the new All-Terrain AUVs can revolutionise new applications such as close-proximity imaging, photomosaic generation of subsea environments, photogrammetry, bathymetric mapping of intricate underwater terrain and structures, under-ice mapping, stop-and-inspect functionalities.

According to the designers, the range of two-person portable units can provide high-quality data at an attractive cost. The new system has a number of key features. By bringing sensors closer to areas of interest, it will be able to produce Ultra high-quality data. Capturing high-resolution data elevates autonomous ocean space discovery.

They can also capture 3D photogrammetry and photomosaic of complex underwater environments and structures, while also securing high-quality photos and seabed bathymetry simultaneously.

The All-Terrain AUV offer 360 deg of freedom in roll and pitch, enabling safe exploration of underwater environments like hill-sides, underwater structures, under-ice areas, vessels, harbours, and more. The 2-person portable device weighing from 45 to 65 kg are easily deployable and retrievable, even from small inflatable RHIBS or from shore.

Eelume 300 S

Length:	200 cm
Width	20 cm
Height (ex. antenna)	20 cm
Weight in air:	45 kg
Depth rating:	300 m
Speed	0-5 knots
Endurance/range	11 h / 64 km

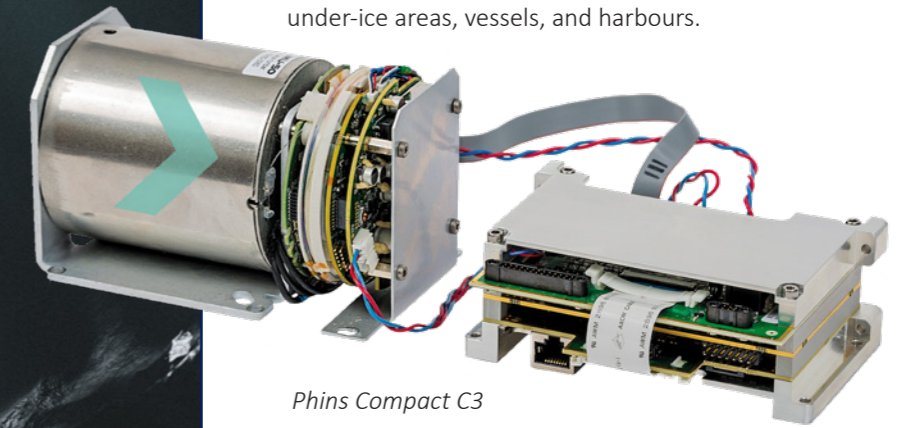


Phins S-series

COMPACT C3 INS

Exail has been selected by Eelume, to supply its Phins Compact C3 Inertial Navigation System (INS) for Eelume's new S-Series all-terrain Autonomous Underwater Vehicles (AUVs).

Providing highly accurate and robust navigation data, the Phins Compact C3 INS will enhance Eelume AUVs' capabilities for efficient exploration, inspection, and monitoring in complex environments such as hillsides, under-ice areas, vessels, and harbours.



Phins Compact C3

Its compact OEM form factor will ensure easy integration into the AUVs, facilitating swift deployment and streamlining operations.

"We required a compact navigation system aligned with our eco-friendly approach, delivering unparalleled navigational accuracy and agility to conduct missions in intricate underwater terrains efficiently.

Exail's Phins Compact C3 INS checks all the boxes," said Thomas Nygaard, CEO of Eelume. "Thanks to this collaboration, our versatile AUVs paired with the Phins Compact C3 are set to totally change the game for underwater exploration."

PHINS COMPACT C3 GNSS/USBL/LBL	3x better than GNSS / USBL / LBL
DVL-Aided straight line perf.	0.20 %TD (CEP 50)
DVL-aided optimal perf.	0.04 %TD (CEP 50)
No aiding for 60s / 120s	0.6m / 2.2m (CEP50)
Heading accuracy	
With GNSS (or USBL/LBL) & DVL	0.10 deg
Roll and pitch dynamic accuracy	0.05 deg RMS

UNDERWATER CABLE

WHAT MAKES AN UNDERWATER CABLE?
UT2 SPEAKS WITH SANDER VAN LEEUWEN OF DEREGT CABLES.

Subsea cables are instrumental in supplying underwater systems with electrical, hydraulic or pneumatic power and two-way communications.

Applications can range from connecting remote sensors in very deep waters to carrying large amounts of electricity when connecting wind farms, powering offshore installations from shore or connecting islands or other countries to a central grid.

Complex seismic streamers have to withstand large modulus loads while cables used to lower and retrieve ROVs or ploughs to the seabed must also be strong enough endure significant physical mass.

In general, underwater cables broadly resemble their terrestrial counterparts, but have to confront

far more challenging conditions.

While the design factors of the two remain similar, the potential repair costs are significantly higher in submerged cables. This means having to develop a design that can reliably withstand harsh marine environments, temperature variations, extreme pressures and exposure to salt water, chemicals and marine life over the cable's operational lifespan.

"Although cheaper, off-the-shelf items do exist for simple applications, underwater cables are normally purpose-engineered around a specialist intended function and this typically results in a sophisticated multiple component design," said Sander van Leeuwen, Technical Director at DeRegt Cables

WIRE

One of the most basic units of both power and signal transmission is conductive wire.

The diameter of this wire is proportional to the electric load it can carry. It comes in two variations— a single thicker wire or a number of multi-strand filaments. "Solid wires are the most efficient way of

Cross section of a typical cable. The foil shield under the outer strengthening cables are used as a Faraday cage.

conducting power and signals and these may be particularly useful static applications," van Leeuwen

"If dynamic applications require the cable to flex, then everything above the neutral bending axis stretches while conversely, everything below this accordingly compresses. Cyclical movement will eventually cause a solid metal line to fail due to fatigue stress.

"A common solution is to build up a conductor from numerous wire yarns twisted in a helix. The helix arrangement gives the cable freedom to both bend and elongate without breaking. The bigger the helix angle, the more flexible and stretchier cable becomes.

"For for data transmission, however, excessive strands may pose issues due to the skin effect, where data travels along the outside of the conductor. This can lead to signal distortion in multi-stranded wires, making a solid conductor a better choice for data transfer."

The material of choice for conductor wires is copper. Its inherent advantage is low resistance coupled with good fatigue properties and all for a relatively low price due to the relative abundance of the material. Silver and gold are better conductors but considerably more expensive.

One drawback with pure copper

is that it has a maximum operating temperature of only 100°C, above which it starts blackening and gradually losing its conductivity.

"Another reason copper is a good material is that it can be alloyed with other materials," van Leeuwen. "By adding Tin, the operating temperature increases to 150°C while applying a silver coating can be even more successful.

"Magnesium also improves its strength and fatigue life. Alloying the copper with Cadmium results in considerably greater strength and fatigued life for a little less conductivity, however, while still in common use, the heavy metal is very pollutive and is likely to be banned by the community.

"A good alternative material Aluminium. It has a low density of only 2.7kg /Lit (compared with nearly 9 kg /Lit for copper) but has poor fatigue characteristics.

Its low mass makes it ideal for overhead high voltage lines, particularly when combined with steel wires for strengthening, but subsea companies are also looking at this cheap material for long-distance subsea power transmission applications.

"In the far future, Graphene, with its quantum effects of superconducting, promises great conductivity. At present, however, it is still confined to the laboratory, but if cost decreases and availability increases, it may conceivably become common."

At certain voltages, the electrical field can become so strong, that the electrons will effectively jump into adjacent conductors resulting in a short circuit, and generating sparks between the lines.

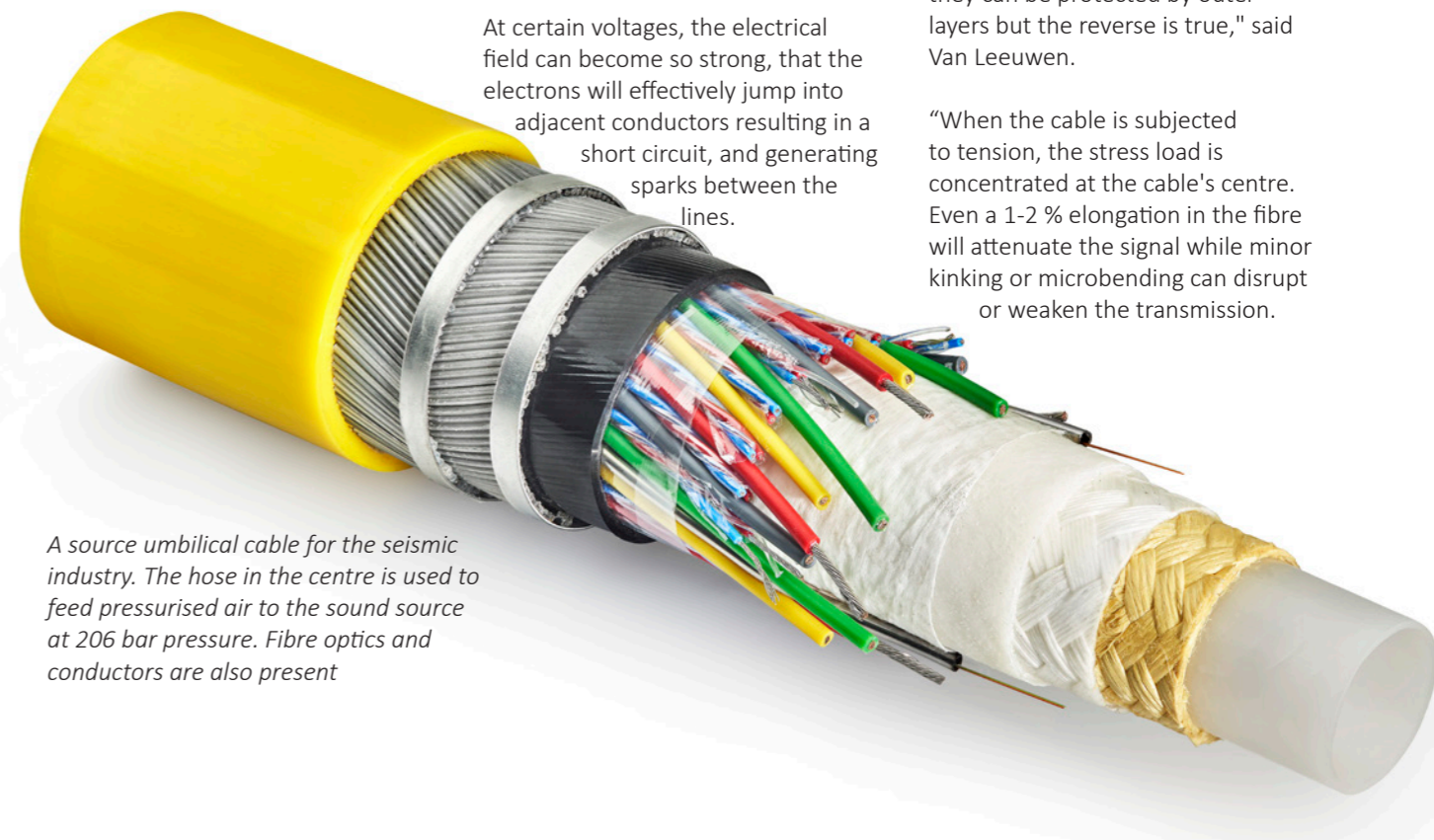
The bare copper wires are therefore normally clad with an insulation material with a higher dielectric strength. This cladding helps shield power conductors from induced electromagnetic frequencies. Similarly, in communications cables, crosstalk or signal interference can be introduced from neighbouring wires.

FIBRE

For communication systems, optical fibres can carry a tremendous amount of traffic- magnitudes than copper conductors. The disadvantage is that they can be very fragile

"One may imagine that these delicate fibres might be positioned at the centre of the cable so that they can be protected by outer layers but the reverse is true," said Van Leeuwen.

"When the cable is subjected to tension, the stress load is concentrated at the cable's centre. Even a 1-2 % elongation in the fibre will attenuate the signal while minor kinking or microbending can disrupt or weaken the transmission.



A source umbilical cable for the seismic industry. The hose in the centre is used to feed pressurised air to the sound source at 206 bar pressure. Fibre optics and conductors are also present

"Instead, the fibres are typically positioned between larger wires nearer the periphery and housed in a steel tubes that offer high crush resistance under pressure.

"Known as STFO (Steel Tube Fibre Optics), FIMT (Fibre in Metal Tube) or FIST (Fibre in Steel Tube), this consists of a small-diameter steel tube containing oxygen-scavenging silicone gel. The fibre can move freely inside the tube.

"The size of the tube may vary from containing just a few fibres to maybe a bundle of 50. The diameter of the protective steel tube depends on the expected water depth and the hydrostatic pressure that it has to withstand. Wall thickness of 6-7mm are not uncommon.

"Sometimes, large export cables such as those in North Sea wind farms incorporate thick power conductors with steel tube fibre optics.

"It is not possible to induce signal interference into the fibre but the power cables may transfer heat into the steel tube, causing damage to the line. One solution may necessitate running the conductor and optical fibre as separate lines.

TAPES

It is common for subcomponent bundles to be bound together with tape. Polyester tape is commonly used because it is very slippery.

"If a tightly-bound dynamic cable moves, the bending moment may

cause the one part to compress and the opposite side to stretch," said Van Leeuwen. "Wrapping polyester tape causes the layers to slide past each other and reduce stress.

"Sometimes, a metallic foil tape is used which can also form a Faraday cage to keep all the electromagnetic disturbance on the outside from being induced into the line. Copper or aluminium foil excels in screening against high-frequency noises but are less effective against low-frequency interference."

STRENGTH

Most cable designs require some sort of strength member to limit distortion and provide protection.

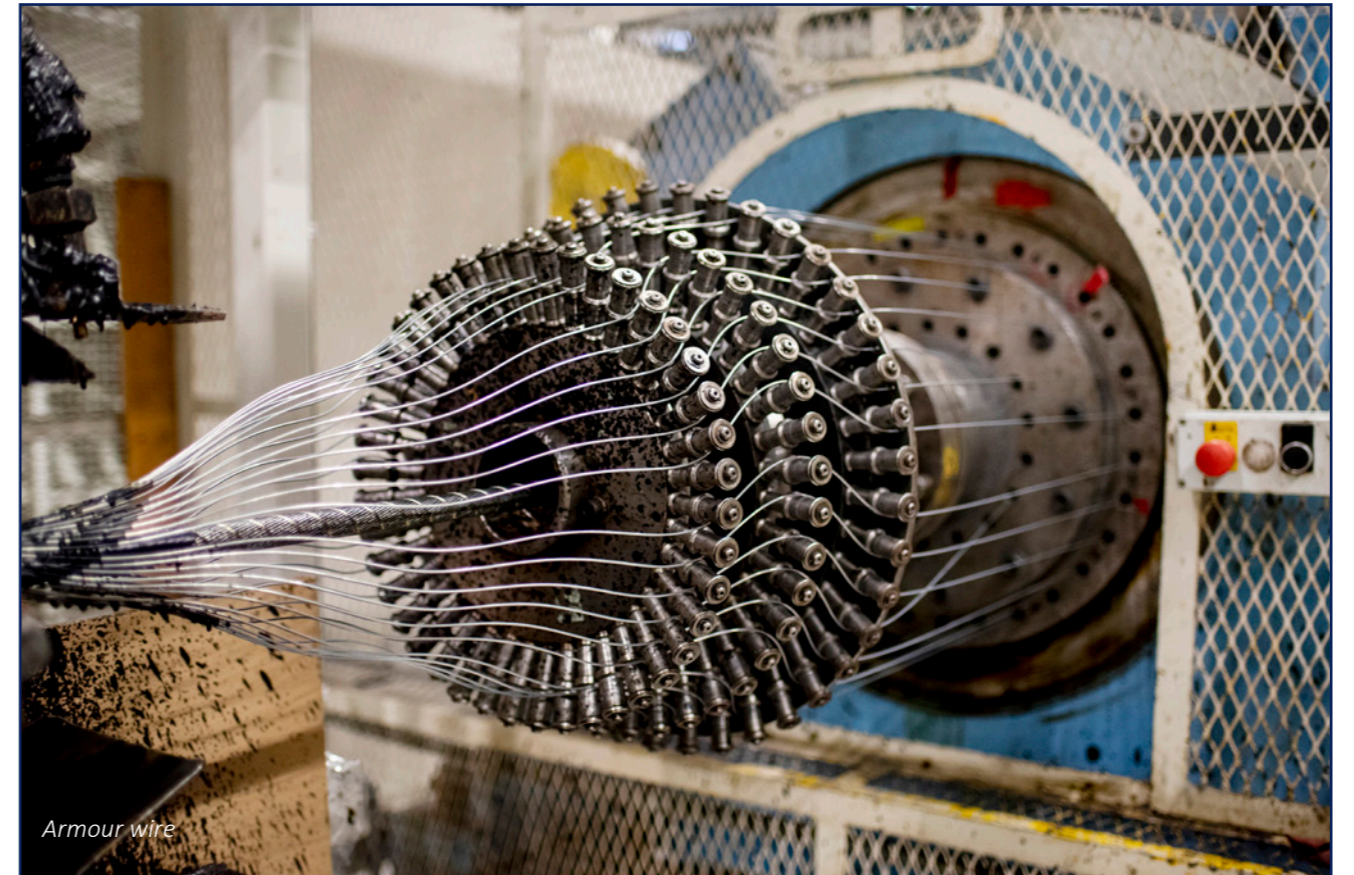
A steel armour wire wrapped helically around the cable body is a good way of providing radial strength, but it doesn't prevent elongation. In the same way that a classic land telephone handset cable works, the helix simply extends.

To achieve maximum support it is necessary to apply a second helical armour layer wrapped in the opposite direction of spin to the first, thus balancing the torsion generated. The result is known as being torque balanced.

"In practice, even torque balanced cables have some imbalance because of manufacturing tolerances and material deviations. It is important, therefore, that the cables don't rotate any more than 2deg for every metre," said Van Leeuwen.

OUTER COVERING

At the outside of the cable is a



waterproof jacket that provides chemical resistance, physical abrasion and protection against sea water. It may also provide protection against ultraviolet radiation from the sunlight which can inflict degradation of the polymer surface over time.

"Ultraviolet degradation is true of surface cables, but this also applies to underwater cables positioned 3-10m in the water but still in the photic zone," said Van Leeuwen. "Elsewhere, many underwater cables such as seismic cables are stored without cover on the winch on the back deck of a boats.

"In applications where the cables are

exposed to UV light for a long time, the industry has devised two main strategies to protect them.

"Many people like prefer bright colours with their inherent ease of visibility. One is to reflect the UV, possibly by adding titanium.

"A more common strategy, however, is to absorb the light and the easiest way to do this is to add carbon black.

"Carbon black has the additional advantage that it consists of very small molecules and it, therefore, act as a lubricant when the external jacket is extruded on the cable.

"The most common coating materials is polyethylene (which comes in high density version, low density version, cross-link polyethylene and semi-conductive polyethylene.

"Thermoplastic elastomers have good properties in terms of very high toughness and a very low creep.

Polypropylene is also commonly used, but if toughness and abrasion resistance is required, nylon is a very good option.

Another alternative is from thermoplastic rubbers which can be extruded in conventional ways and do not need a vulcanisation process.



An extrusion line

CABLE MANUFACTURING

The manufacturing process starts with assembling the subcomponents, some purchased while others preassembled on site. These are introduced into the lay-up machine.

These machines can be horizontal or vertical, the former requiring more space but offering the ability to accommodate more components.

Smaller, less complex cable designs can be manufactured by a single run through a lay-up machine. More sophisticated cables, however, either require a larger lay-up machine, or by multiple runs, each pass adding another layer.

"There are two basic systems," said van Leeuwen. "The first is known as a Planetary Strander. Bobbins containing the subcomponents rotate around the core like planets orbiting around the sun. As this central cable passes through the machine, the bobbins wrap around it. This effectively results them being laid in the helix.

"The other method is called a Drum Twister. The planetary Strander has an inherent disadvantage in that the heavier or larger the components and more complex the design, the a larger lay up machine needs to be to produce the finished cable. The drum twister works in the opposite way.

"Instead of the subcomponents rotating around the completed product, it is the drum with the completed product, that rotates. This means that subcomponents are fed onto it from stationary reels. We do have some drum twisters in our factory for small components but we use planetary systems more complex designs."

So, how many individual components go to make up a cable? "We recently fabricated one cable containing 496 different components. Seismic cables tend to particularly complex. They can contain by power quad conductors and multiple fibre optic lines", said van Leuwen.



Stored bobbins containing individual cable subcomponents waiting to be installed on the lay up machine



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ALLEIMA

Alleima recently unveiled a new alloy designed specifically for subsea umbilicals SAF 3007 is the latest addition to the duplex family of Alleima, a super-duplex stainless steel grade developed for subsea umbilicals.

The new tube offers a safe, lighter, stronger and more efficient alternative to SAF 2507, the current standard. With superior strength, fatigue properties and corrosion resistance.

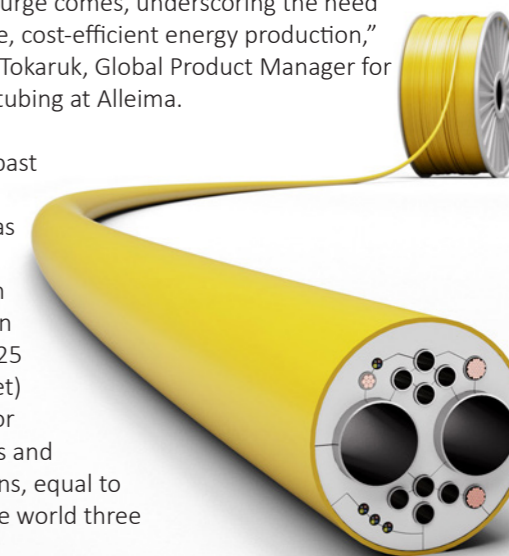
The new tube product represents the next generation of super-duplex seamless tubing developed specifically for the offshore oil and gas industry. It builds on the success of SAF 2507 (UNS S32750), which has become the industry standard, and further advances the duplex revolution that Alleima pioneered decades ago.

STRONG ENERGY DEMAND

"Across the globe, the demand for energy is growing

strong. We see a rising tide of activity in the oilfields off the coast of Brazil, in the Gulf of Mexico, North Sea and Southeast Asia. Following a dip during Covid, this new surge comes, underscoring the need for reliable, cost-efficient energy production," says John Tokaruk, Global Product Manager for umbilical tubing at Alleima.

Over the past 30 years, Alleima has supplied more than 160 million meters (525 million feet) to all major fabricators and applications, equal to circling the world three times.



EDGETECH HI-RES SONAR INSTRUMENTAL IN MISSING AIRCRAFT DISCOVERY

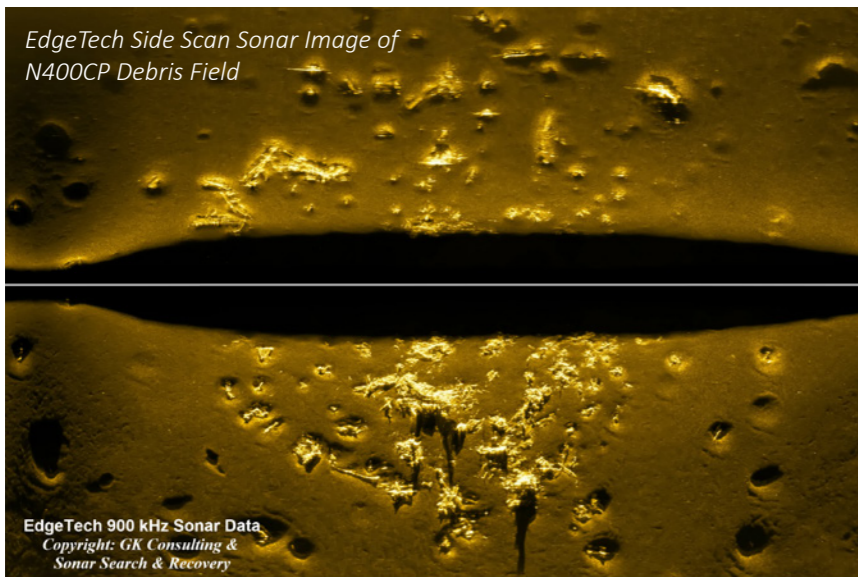
EdgeTech, a leader in high resolution sonar imaging systems and underwater technology, recently learned that its industry leading side scan sonar technology was used to help find an aircraft that has been missing for over fifty years.

In 1971 a plane departed from Burlington International Airport bound for Providence RI but crashed *en route*, presumably, in Lake Champlain. Searches were carried out at the time of the crash, but weather made the operations difficult. In subsequent years many other searches were completed to no avail.

In May of this year, Garry Kozak utilizing pieces of information from prior surveys, along with Hans Hug, Tim McDonald and Bruce Stebbins, did a search for the missing Rockwell Jet Commander utilizing a high resolution EdgeTech 4125i Side Scan Sonar. The Rockwell Jet Commander was successfully located and imaged with outstanding, almost photographic, resolution.

EdgeTech's 4125i Side Scan Sonar System was designed with both the Search & Recovery (SAR) and shallow water survey communities in mind. The 4125i utilises EdgeTech's Full Spectrum CHIRP technology, which provides two dual simultaneous frequency sets ideal for maximizing range and resolution during searches. A more detailed narrative surrounding the events of this fateful 1971 plane crash and the ensuing years of search will be printed in the coming months.

EdgeTech Side Scan Sonar Image of N400CP Debris Field



EdgeTech 900 kHz Sonar Data
Copyright: GK Consulting & Sonar Search & Recovery

EMO OMNI

EMPOWERING SUBSEA CONNECTIVITY

The customisable EMO Omni multiplexer is designed to meet the evolving needs of underwater operations, from offshore energy projects and marine research to environmental monitoring. Offering unmatched adaptability and operational efficiency, it is an essential tool for subsea operators.

Built on the tried and trusted MacArtney EMO and NEXUS platforms, the new HD fibre optic video and multibeam EMO Omni multiplexer represents a significant advancement in underwater data acquisition, enhancing the performance and scope of subsea projects.

Positive initial customer feedback confirms that it confidently meets the growing demand for adaptable, robust telemetry solutions – notably, end-user requests for bespoke multiplexers that deviate from the standard portfolio in terms of size or features further validate its market relevance.

The compact EMO Omni ensures seamless data collection and analysis, enabling informed decision-making and streamlined operations. High data output and real-time communication capabilities support multiple instruments and sensors with integrated diagnostics and remote monitoring features.

This functionality enhances operational efficiency and minimises manual interventions, ensuring consistent connectivity and efficient data transmission and management in diverse underwater environments. Customisation at its core.

At the core of the EMO Omni lies its highly customisable nature, tailored to meet the unique requirements of each operation and adaptable to a diverse range of subsea applications within offshore energy, naval projects, ocean science, marine research, and environmental monitoring.

The EMO Omni's adaptability extends to system integration, power supply,



EMO Omni multiplexer

and material requirements, drawing on decades of MacArtney's industry experience and exceptional workshop capabilities. Swift customisation, including bespoke harness cables, is readily available globally through our local workshops.

The connectors mounted will typically be from MacArtney brands, such as SubConn, OptoLink and TrustLink. However, the versatility offers flexibility in choosing from a wide selection available at MacArtney.

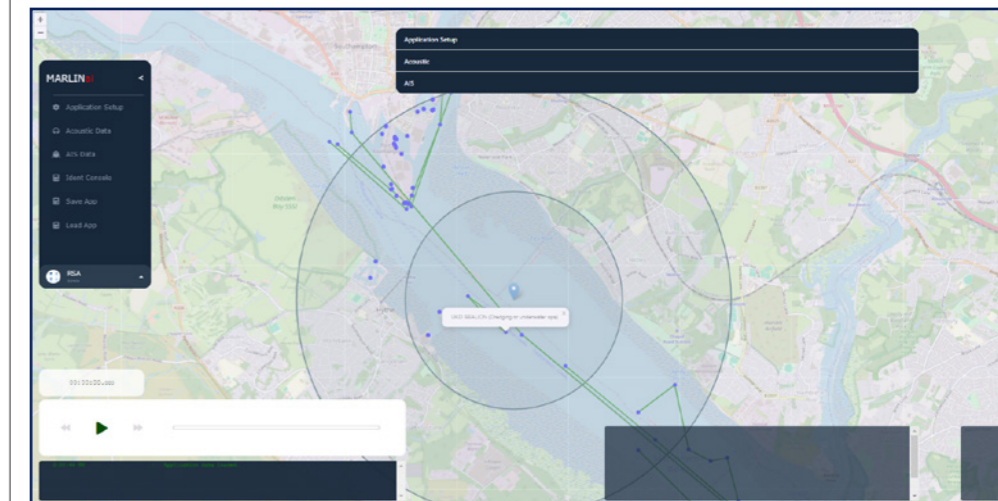
FOCUS ON EASE-OF-USE

Focusing on long-term performance and user-friendliness, such as intuitive interfaces, the EMO Omni aims for minimal downtime through ease of maintenance, efficient troubleshooting, and quick issue resolution. It seamlessly integrates with existing systems, enhancing subsea project performance and mission success.

MacArtney's newest multiplexer addition is available globally via local operations in North America, Europe, and the Asia Pacific.



ANOMALY DETECTION AND DATA LABELLING SOFTWARE



MARLIN update

Ocean science technology specialist RS Aqua has announced a significant update to the MARLIN project.

In collaboration with the University of Southampton, and supported by funding from Innovate UK, the MARLIN project is set to deliver several new technologies including a web application that can detect unusual underwater noise using machine learning, cloud connectivity and an intelligent network of underwater sensors.

The latest development in the MARLIN project is the successful creation of a software application that allows us to correlate historical automatic identification system (AIS) data and underwater noise signatures.

By automatically linking acoustic signatures to individual vessels, this innovative software enables real-time visualisation of data on a geographic information system (GIS) platform and acoustic data labelling.

Dr. Ryan Mowat, Director of Innovation at RS Aqua, elaborates on the significance of this advancement:

"The new MARLIN software application represents a shift in ocean monitoring technology. For the first time, we can identify potentially illegal vessel activity in real-time using underwater noise. This capability will enhance our understanding of ocean ecosystems and strengthen efforts to combat unregulated fishing."

This classification technology in the MARLIN project marks a crucial milestone in ocean conservation efforts. By utilising labelled acoustic data from vessels, we have the potential to identify and track illegal, unreported and unregulated (IUU) fishing activity, contributing to the protection of marine biodiversity and the sustainability of our oceans.

The MARLIN team are now adding AI algorithms to the software application to automate the detection of IUU fishing.

ILLUMINATING THE UNKNOWN

THE MAKING OF THE RMS TITANIC DIGITAL TWIN

Voyis, a provider of advanced underwater imaging systems in Waterloo, Canada, joined forces with subsea technology partners Sonardyne and EIVA to provide sensor systems to Magellan for their groundbreaking survey that captured the first complete Digital Twin of the RMS Titanic wreck site.

This collaborative effort has resulted in an extraordinary scaled digital twin of the entire bow and stern of the famous wreck, along with the surrounding debris field, enabling researchers and scientists to start to re-explore the vessel with the greatest level of detail ever recorded.

The 3D model showcases the site as if the ocean had been drained away, offering a snapshot in time of this iconic historical asset before it degrades beyond recognition (Magellan Digital Twin).

The survey was completely non-intrusive thanks to Magellan's deep water survey expertise, inhouse cameras systems, proven mapping equipment and Voyis' long range optical systems. This offered a sustainable way to further understand the conditions of the Titanic without compromising the wreck or surrounding ecosystem.

The Titanic, resting at a depth of approximately 3800m (12 500ft) in the Atlantic Ocean off the coast of Newfoundland, Canada, has long been a subject of fascination and mystery since its tragic sinking in 1912. The aim of this ambitious project was to shed new light on the circumstances surrounding the disaster and utilize cutting-edge underwater optical technology to record the current state of this iconic wreck.

In summer 2022, Magellan, a leading deep-sea mapping and survey company, was provided with Voyis' underwater imaging sensors to complement their own systems and conduct the extensive optical survey.

SUBSEA CAMERAS AND NOVA LEDS ILLUMINATE THE WRECK

Voyis provided its state-of-the-art Observer & Nova subsea imaging system in support of this endeavour. With an actively cooled high-dynamic range camera and more than ½ million lumens of flash lighting, this setup enabled the best possible colour images of the wreck.

Over 700,000 images were reliably captured during the multi-day survey of the region, recording millimetric details of every aspect of the site. At 3,800m below the sea, the Observer Pro delivered clear, accurate images that were automatically corrected for both colour & lighting.

This delivered the image quality and consistency needed to produce Magellan's seamless Digital Twin. This resolution and colour accuracy,

powered by Voyis' proprietary True Colour correction, has never been deployed on a wreck of this size, and was key in removing the blue and green hues that are typical in subsea optical survey.

This precise visual data formed the foundation for generating the comprehensive 3D model of the entire ship, an immense processing undertaking by Magellan. Voyis is now able to release some of the colour corrected original images in full resolution.

In addition to the Observer & Nova, Magellan also trialled a Voyis Insight Pro laser system to scan the wreck and debris field. The Insight Pro underwater laser scanner may provide researchers with the quantitative capability to directly measure even the smallest features.

The laser model can complement the image-based Digital Twin to help further understand the rate of degradation of the historic site and measure the profile and scour on the feature-limited seabed. Voyis is also sharing limited exports from the laser model.

CRITICAL SUPPORT FROM SONARDYNE AND EIVA

Delivering good images and an accurate 3D model requires more than great cameras, and trail laser scanners.

Precise and accurate positioning throughout the survey is essential to ensure that complete coverage is achieved and to provide an accurate flight path for 3D model processing.

As a renowned provider of innovative underwater positioning and navigation technologies, Sonardyne supplied Long BaseLine (LBL) equipment and an acoustically aided SPRINT-Nav Hybrid Navigator.

Sonardyne and Magellan have worked extensively together to develop and refine these systems since Magellan invested in SPRINT-Nav across its fleet of 6k rated work class ROVs, with the result that the advanced INS/DVL/LBL technology ensured reliable and robust subsea navigation in the challenging operating conditions at the Titanic site.

Also critical to mission success is real-time feedback to the surveyors at the surface, and here EIVA, a sister company to Voyis and Sonardyne, contributed its advanced navigation and survey software capabilities to the project.

EIVA's NaviSuite software solutions facilitated the efficient collection and visualization of the vast amount of image and navigation data collected during the survey.

UNVEILING NEW INSIGHTS INTO THE TITANIC'S HISTORY

This sensor package offered to Magellan's project by Voyis, Sonardyne, and EIVA represents a significant milestone in underwater innovation.

Magellan's unprecedented reconstruction of the Titanic has demonstrated the ability to generate incredibly accurate models of our oceans, allowing us all to see the depths like we see the surface.

VIGILUS

UNDERWATER SURVEILLANCE INNOVATION

Cellula Robotics has launched its latest innovation in underwater robotics – Vigilus. This acoustic surveillance array represents a cutting-edge advanced submersible surveillance system designed for underwater monitoring and security purposes.

Cellula's Vigilus acoustic surveillance array (prototype pictured in top right corner being deployed) represents a cutting-edge advanced submersible surveillance system designed for underwater monitoring and security purposes.

Vigilus is a state-of-the-art submersible surveillance array, comprising of acoustically-meshed environmental sensor nodes, poised to revolutionize underwater monitoring and security. The Vigilus nodes, strategically positioned on the seafloor multiple kilometres apart from one another, form an interconnected network of listening stations that act as an underwater "trip wire".

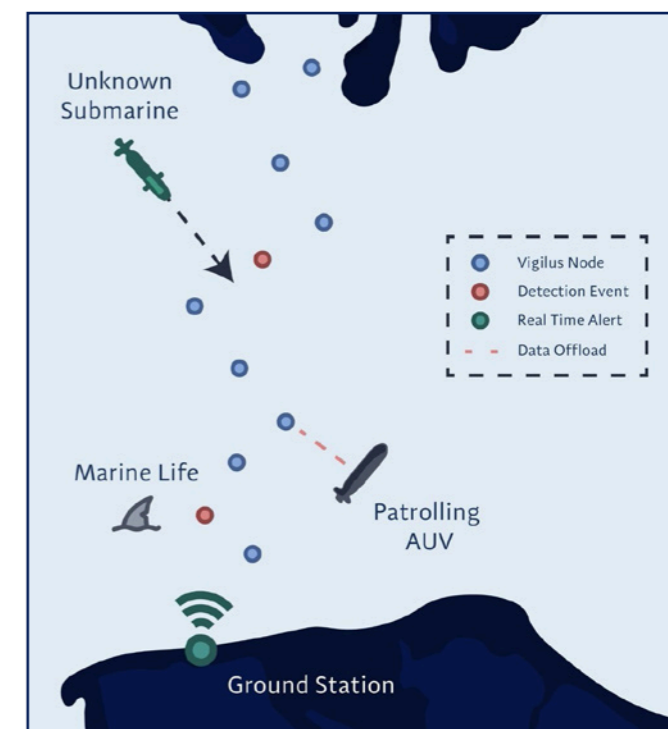
Notably, these nodes boast a compact, cable-less design, facilitating effortless deployment from small watercraft or covertly via a large Uncrewed Underwater Vehicle (UUV), even in challenging environments such as beneath ice sheets. This adaptability positions Vigilus as the ultimate tool for sophisticated surveillance and environmental monitoring operations in hard to access areas, including chokepoint surveillance in the Arctic region.

Each Vigilus node is equipped with cutting-edge sensors capable of seamlessly collecting, processing, encrypting, and responding to acoustic and environmental data. This functionality ensures the rapid generation of alerts, which can be effortlessly shared among nodes and transmitted to other assets in the vicinity, including UUVs, as well as to Vigilus' shoreside gateway, which provides secure, near real-time alerts for timely data-driven decisions.

Furthermore, Vigilus offers an additional layer of strategic advantage, as each node can emit acoustic pings to serve as a deterrent while deployed.



Cellula's Vigilus acoustic surveillance



The genesis of Vigilus can be traced back to a successful prototype developed for the Royal Australian Navy (RAN). This innovation represents a monumental leap forward in underwater surveillance technology.

Innovation, Science, and Economic Development Canada has awarded a contract to Cellula Robotics for its Vigilus array following a successful call for proposals under the Innovative Solutions Canada Testing Stream. Transport Canada is acting as the technical authority for the contract.

LIDAR BUOY



Floating measuring station

Ignitis Renewables has been conducting wind and meteorological measurements for the development of the first offshore wind farm in the Baltic States. The measuring station, installed on a special buoy, will provide environmental monitoring data in real time to help make decisions on developing the project of strategic importance to Lithuania's energy sector.

These data will also help the company to achieve its goal of installing 700-megawatt (MW) capacity offshore wind turbines of by 2030. This would meet up to a quarter of Lithuania's current electricity demand.

"To have accurate data on prevailing wind speeds and other hydro-meteorological parameters such as wave height, direction and speed of currents, air and water temperature, as well as bat activity in the maritime area of the offshore wind farm, our partner Fugro, towed one of their wind LiDAR buoy's using specialised equipment to the maritime area of the future offshore wind farm and secured it," said Dainius Stepanonis, Project Manager at Ignitis Renewables who is responsible for marine research.

It is planned that Lithuania will be the first of the Baltic States to have an offshore wind farm. The maritime area in the Baltic Sea designated for the offshore wind farm is approximately 120 km² and is located at least 36 km away from the shore, approximately 60 km away from the Port of Klaipėda. The depth at the maritime area ranges from 28 to 48m, and the average annual wind speed there is around 9–10 m/s. It is these data that will be adjusted during this stage.

OBJECT CLASSIFICATION

Kongsberg Discovery has developed a new analysis tool in partnership with underwater imaging specialist Cathx Ocean. This radically reduces the time and effort required to detect and classify objects of interest in seabed surveys undertaken by Kongsberg's HUGIN AUVs. This, in turn, reduces costs for survey owners while freeing up valuable resources.

Kongsberg HISAS scans of the seafloor contain extensive visual information that requires a highly trained eye to manually detect objects of interest. This time-consuming process ties up valuable resources in sonar image analysis.

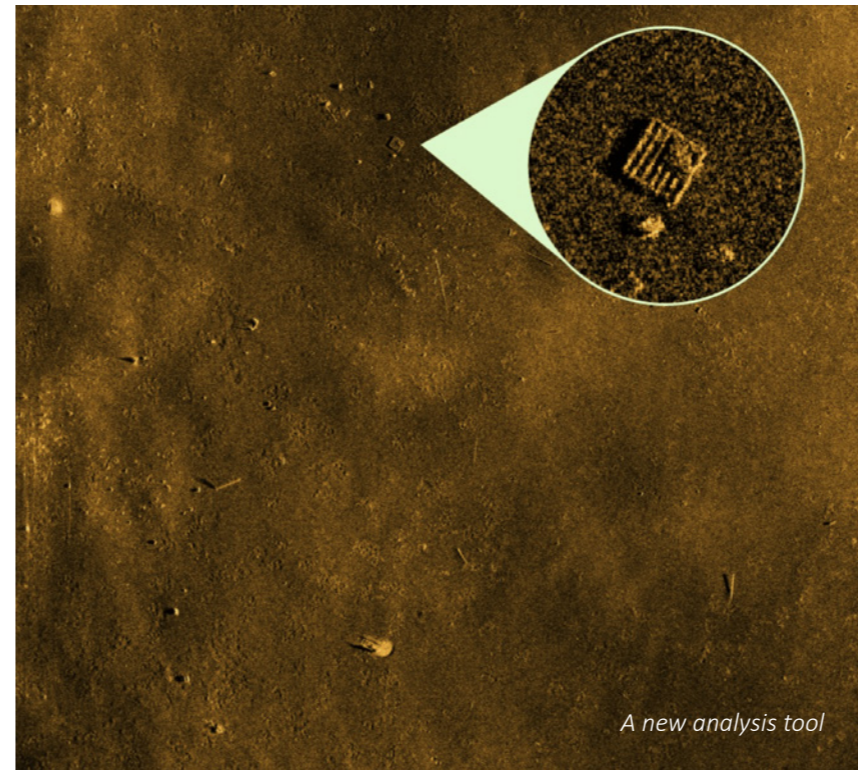
Automating the object identification process using the novel SAS Target Assistant provides major workflow benefits in terms of earlier decision-making. The application runs in the background providing consistent and reliable detection, leaving users to focus their mental capacity on the most valuable task of evaluating and classifying the potential objects of interest.

"In conventional survey analysis, the operator has to laboriously play through the scanned image data, tagging then measuring and classifying objects of interest and, finally, building a target list that can be exported. SAS Target Assistant automatically detects and measures objects of interest and creates a target list for review/confirmation, further analysis, and export," said Adrian Boyle, CEO of Cathx Ocean.

The tool allows users to predefine the desired characteristics (size and shape of objects) they require to rapidly identify targets matching such specifications.

"Leaving the tedious work of initial scanning to the algorithm frees up human personnel to concentrate on more complex, high-value analysis tasks while speeding up the delivery of survey results. With longer-duration AUV missions, as well as increases in the area and frequency of surveys being asked of AUV operators, time literally is money," Mr Boyle added.

SAS Target Assistant requires no additional window or display/monitor, as it is fully integrated into the Reflection PMA system. "It's a great example of how machine learning and sensor intelligence can be used to simplify



A new analysis tool

often demanding workflows, reducing the burden on human operators while also producing reliable results according to survey specifications and deadlines," Sigurd Fjerdingen, VP Products in Kongsberg Discovery, said.

HUGIN AUVs have been successfully deployed for commercial surveys and defence operations worldwide in both shallow and deep water in marine environments ranging from polar to tropical.

The partnership with Cathx Ocean aims to change how these AUV surveys are performed today and into the future. The collaboration serves as blueprint for further co-development initiatives to enhance the HUGIN Open Data Processing ecosystem.

"Working with specialist partners is the most efficient way to develop new robust applications that cater to ever-evolving market requirements. By introducing SAS Target Assistant, we can supercharge survey analysis for customers while reinforcing the exemplary operational record of HUGIN vehicles over the last quarter century," Mr Fjerdingen concluded.

5001 SERIES ROV LED

The Italian company Subsea LED has launched its new LED 5001 series of underwater lights. These small and lightweight LED devices fit into a compact and rugged hard-anodized 6061 T6 aluminium housing with a height of 80mm and a 62 mm diameter to body. The length is 139 mm.

They produce a wide 120deg diagonal beam at a typical colour temperature of 5000° K, other options being available. The lamp has a 3000m depth rating and an operating temperature of -10° C +40° C.

The series is fully compatible with the plug and play units currently used on ROVs vehicles such as the Seaeye Cougar and Panther, however, they are more powerful than the light (5000Lumens vs 3200Lumens). They are able to accept wide input Voltage range, both AC & DC but typically 200mA (Max) at 250V DC.

The High Efficiency CREE XHP 70.3 LEDs produce a Colour Rendering Index greater than 80 (90 available on request). They have analogue and serial intensity control options. The light features the company's advanced LED driver, featuring a flicker-free dynamic intensity control.

To save on having to return units to base to be repaired or modified, this underwater light is field serviceable but the lamps typically last for 60,000 hrs. The company can provide an external unit that can be connected to the light to configure the light channel without opening the light body and change it through dip switch.



PISCIVORE

A NEW AUV-MOUNTED CAMERA SYSTEM FROM MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

Studying marine animals can pose significant challenges due to their wide dispersion across remote oceanic regions and their association with rapidly changing habitats. These highly mobile species often avoid boats and submersibles, complicating observational efforts.

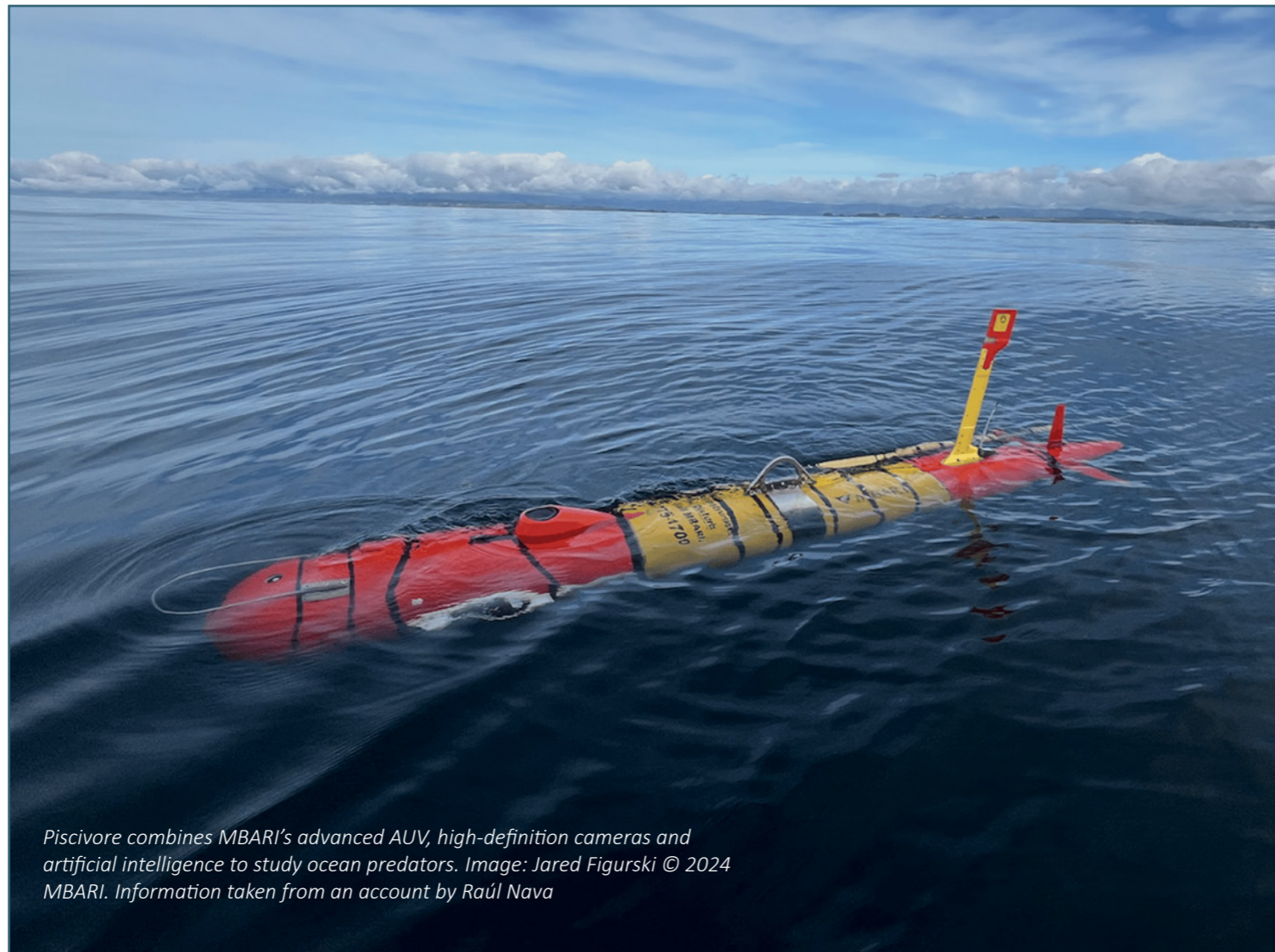
The Monterey Bay Aquarium Research Institute (MBARI) engineers have developed a novel camera system called the Piscivore, which it says, offers unprecedented insights into the behaviour of ocean predators.

The camera system is mounted on the long-range autonomous underwater vehicle (LRAUV), an advanced underwater vehicle developed by MBARI engineers. This can carry a variety of instrumentation payloads to study the observe and document the dynamic environments of these elusive marine animals.

The LRAUV, a versatile platform approximately 2m long and weighing 110 kilograms, supports various scientific instruments and sensors.

Pilots remotely monitor the LRAUV from shore-based facilities using cellular and satellite communications, directing it to regions of high biological productivity. They can target hotspots of ocean productivity where food is plentiful and predators will be most abundant, then send Piscivore in for a closer look.

PISCIVORE
MBARI engineers originally developed the Piscivore system



Piscivore combines MBARI's advanced AUV, high-definition cameras and artificial intelligence to study ocean predators. Image: Jared Figurski © 2024 MBARI. Information taken from an account by Raúl Nava

to observe marine life from the perspective of this nimble underwater robot as it travels across the fertile waters of Monterey Bay.

The Piscivore system is based on two high-definition cameras – a forward-facing camera capturing footage as the LRAUV navigates the terrain and a rear-facing camera documenting animals that approach from behind.

The camera compensates for the skittishness of pelagic predators by dragging a piece of textured metal in its wake.

As the metal attractor swirls in the currents, it catches sunlight and flashes like a silvery fish, piquing the curiosity of predators. The cameras record continuously to see who approaches.

Piscivore's design allows it to collect vital data on the environmental conditions these predators encounter, including measurements of salinity, temperature, chlorophyll, oxygen, and water chemistry. This contextual information is critical for understanding the habitats these animals frequent and how they are affected by changing ocean conditions.

Each deployment lasts approximately two weeks. After its mission is complete, MBARI's marine operations crew retrieves the vehicle and downloads the camera data on shore.

Each deployment logs approximately 200hrs of high-definition video, 100hrs from each of Piscivore's two cameras. Machine-learning algorithms developed by MBARI's software engineers leverage the power of artificial intelligence to help researchers quickly review and catalog Piscivore's observations.

Over the past year, Piscivore has observed six different species of seabirds, including diving cormorants. Seabirds are highly mobile animals that nest and shelter on land, but feed at sea. They often migrate seasonally, sometimes traversing thousands of kilometers. Seabirds underscore the connection between land, sky, and sea and are sentinels that can reveal important information about ocean health.

MBARI engineers are continuously enhancing the capabilities of the LRAUV and Piscivore system, integrating on-board AI for real-time video analysis, developing new attractors, and incorporating stereo imaging cameras for estimating animal sizes. They are also exploring complementary environmental DNA (eDNA) sampling techniques to provide further insights into marine biodiversity.

Piscivore's deployments in 2023 alone covered approximately 1,800 kilometers in the Monterey Bay area, capturing footage of 10 species of fish, four species of

marine mammals, and six species of seabirds. The labeled video data from Piscivore is being added to the FathomNet database, aiding in training AI algorithms to recognize and catalog marine organisms. This extensive dataset is invaluable for researchers aiming to understand the complex interactions within marine ecosystems.

MBARI's technological advancements are not confined to observation alone. The data collected by Piscivore and the LRAUV are shared with educational and conservation partners to inform and support ocean management and protection efforts. Their collaboration with Saab, to commercialise the LRAUV platform further extends the reach of this technology, enabling global ocean exploration communities to customize the vehicle for their unique scientific needs.

"Piscivore exemplifies the integration of science, engineering, and marine operations at MBARI," said Jared Figurski, the principal investigator for the Piscivore project.

"Our multidisciplinary approach allows us to address significant questions about how changing ocean conditions impact marine predators and their ecosystems."

As MBARI continues to innovate, the vision is to deploy a fleet of advanced robotic technologies that operate synergistically.

These technologies will provide real-time data to resource managers, enabling more effective monitoring and conservation of ocean health.

TIDAL STREAM

Tidal stream or tidal current energy harnesses the changes in sea levels due to gravitational interaction between the sun, Earth and moon.

It works by capturing kinetic energy from fast-flowing water driven by tidal currents. This is most effective in areas where tidal currents are intensified by topographical features including headlands, inlets and straits or other places where the shape of the seabed forces water through narrow channels

Tidal stream devices come in various designs but the industry has *generally* converged around concepts featuring turbines on a horizontal axis. These are similar to wind turbines but they tend to be smaller in size and capacity (around 1–2 MW as opposed to 8–12 MW for an offshore wind turbine)

Similar to wind farms, multiple tidal stream turbines can be deployed in the same location to form arrays. These can either be fixed on the seabed or have floating foundations.

The UK has around 10 MW of tidal stream generation capacity installed, which represents over half of the world's currently operational capacity.

As a sizeable domestic renewable resource with high predictability, tidal stream energy has the potential to contribute to sustainable economic growth in the UK, enhancing net zero efforts, improving energy security and generating jobs across the country.



Tidal Stream has the potential to lower UK energy system dispatch costs by £100-£600m annually by 2050, contingent on the trajectory of cost reduction achieved over the next decades.

Offshore Renewable Energy (ORE) Catapult is the UK's leading technology innovation and research centre for offshore renewable energy. In March 2024, **ORE Catapult** launched its *Tidal Stream Technology Roadmap* which looks at various aspects of the technology demonstrating how cost reduction is crucial in enabling an accelerated growth trajectory for the sector.

The report discusses how cost reduction through technology innovation is essential for the tidal stream (TS) sector's growth, targeting around 1GW of installed capacity in the UK by 2035, as recommended by the Marine Energy Council (MEC).

There are two basic types- fixed and floating, each having distinct advantages. Fixed devices, being

	MICROSCALE <100kW	SMALL SCALE 100kW - 1MW	UTILITY SCALE >1MW
Fixed foundation Horizontal axis turbine	Guinard Energies Nouvelles (FRA) P66, P154 ORPC (USA) RivGen	Nova Innovation (GBR) M100, M100D, M500D, QED Naval (GBR) Subhub Community Design Sabella (FRA) D08, D10, D12 Proteus (GBR) AR500 Verdant Power (USA) TriFrame Gen5 Hydrowing (GBR) HW500, HW1000	Andritz Hydro Hammerfest (AUT) Mk1 1.5MW Turbine Proteus (GBR) AR1500, AR2000, AR3000 Hydrowing (GBR) HW1500
Fixed foundation Vertical axis turbine	Instream Energy Systems (CAN) 25kW Hydrokinetic Turbine System	Minesto (SWE) DG100, DG500 Seacurrent (NLD) TidalKite	Hydroquest (FRA) Oceanquest 1, Oceanquest 2
Fixed foundation Other	Minesto (SWE) Dragon 4		Minesto (SWE) Dragon 12
Floating foundation Horizontal axis turbine		Orbital Marine Power (GBR) SR250 (ScotRenewables) Sustainable Marine Energy (GBR) PLAT-I 4.63, PLAT-I 6.40 Aquantis (USA) Tidal Power Tug	Magallanes (ESP) ATIR Orbital Marine Power (GBR) O2, SR2000 (ScotRenewables)
Floating foundation Vertical axis turbine	Gkinetic (IRL) CEFA12	Aschelous Energy Ltd (GBR) FITS Platform	
Floating foundation Other		BigMoon Power (USA) Kinetic Keel (prototype) Kinetic Keel (~0.5MW)	

underwater, have minimal visual impact, aiding the consenting process.

With proper environmental planning and compact foundations, their impact on the marine environment can be

minimised. Fixed systems are, however, challenging to retrieve, increasing operation and maintenance (O&M) costs for unplanned maintenance. Their proximity to the seabed limits them to specific site conditions, but tidal developers deliberately seek out highly energetic sites to maximise energy production.

Floating devices, positioned at the water's surface, offer significant O&M advantages since they avoid complex underwater operations. Their installation is simpler, relying on mooring and anchoring systems deployable during slack tides, reducing the need for dynamic positioning vessels. However, floating devices are more complex to engineer and are vulnerable to wave loading, which can affect power delivery quality and device longevity.

There are several other tidal stream (TS) devices being explored, such as oscillating hydrofoils, venturi turbines, Archimedes screws and kinetic keels. Among these, Minesto's "kite" design has shown significant promise. Resembling an underwater kite with a small rotor, it generates electricity by "flying" through the water column, similar to airborne wind technology.

COST

The levelised cost of electricity (LCoE) varies between fixed and floating devices due to differences in scale, design and development stages.

Projects that secured funding through the UK Government energy generation subsidy scheme Contracts for Difference (CfD) for Allocation Round 4 (AR4) must reduce costs below £178.54/MWh by 2027 for commercial viability, a significant reduction from the 2018 weighted LCoE of around £300/MWh. This reduction seems achievable for certain devices like Orbital Marine Power's O2, which targeted an LCoE under £200/MWh for its first deployment at the European Marine Energy Centre (EMEC).

Continuous cost reduction is essential for making TS competitive with other renewable energy sources. Accelerated Reductions have already been achieved through economies of scale and increased turbine capacity. For example, Orbital Marine Power (OMP) scaled up from the 250kW SR250 turbine to the 2MW SR2000 and O2 turbines. Developers like Nova Innovation have also contributed to accelerated learning, deploying 100kW devices and scaling up to 500kW.

Their Shetland Tidal Array grew from three devices in 2016 to six by 2023, achieving cost reductions through increased reliability and reduced cable requirements via a

subsea hub. Despite these advances, manufacturing volume barriers remain, such as inconsistent access to revenue support and long lead times in component manufacturing and procurement, which could cause bottlenecks.

Companies have sought to obviate blade failure by not underestimating mechanical loads during design. This has led to more cautious (and sometimes over-engineered) blade designs, increasing costs.

Standardisation of blades and advanced materials are critical for further cost reductions as rotor diameters increase with the advent of 3MW+ devices.

Long-term cost reductions will rely on continued learning by doing and innovation, as well as further reductions in capital cost. Overall, achieving commercial scale arrays by the late 2020s depends on overcoming manufacturing barriers and continued innovation to drive down costs and increase reliability.

ORE CATAPULT LOOKED AT TEN INNOVATION AREAS WITH A COST REDUCTION POTENTIAL.

1 ROTOR DIAMETER

By increasing rotor diameters, a greater area of tidal flow can be captured, and from this, higher yields can be achieved on a turbine of a given capacity. For example, increasing rotor diameters from 18m to 24m on the devices used at Meygen phase 1A would improve energy yield per turbine by 34%.

INSURANCE

Insurance premiums are high, contributing significantly to the final project cost. A key factor driving high insurance premiums is the lack of performance data available to insurers, making it challenging to determine appropriate premiums for coverage.

This creates a dilemma where developers hesitate to invest in technologies to increase operating hours due to the unavailability of suitable insurance.

Identifying suitable sites for larger rotor diameters presents challenges – especially for fixed-bottom devices

– due to their proximity to the seabed. In many instances, this limits blade length. Floating devices face constraints related to sea surface conditions.

For both types, the costs associated with manufacturing, transporting, and installing larger blades, as well as any necessary design changes to accommodate greater mechanical loads, must be balanced against the potential site-specific increases in annual energy production.

2 SUBSEA HUBS

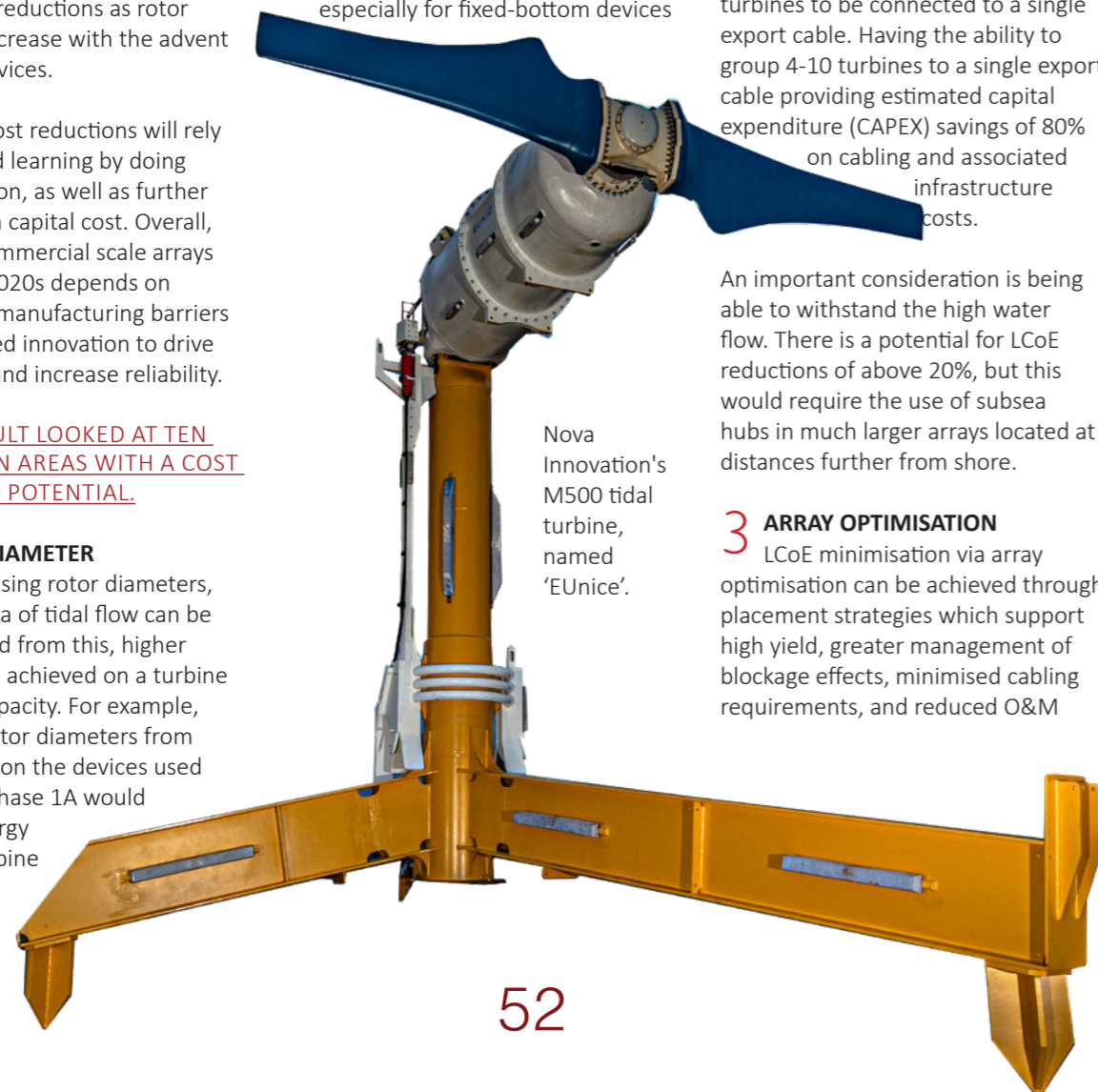
These enable multiple TS turbines to be connected to a single export cable. Having the ability to group 4-10 turbines to a single export cable providing estimated capital expenditure (CAPEX) savings of 80% on cabling and associated infrastructure costs.

An important consideration is being able to withstand the high water flow. There is a potential for LCoE reductions of above 20%, but this would require the use of subsea hubs in much larger arrays located at distances further from shore.

3 ARRAY OPTIMISATION

LCoE minimisation via array optimisation can be achieved through placement strategies which support high yield, greater management of blockage effects, minimised cabling requirements, and reduced O&M

Nova Innovation's M500 tidal turbine, named 'EUnice'.



through improved load prediction and efficiency in marine operations.

Multiple models exist which can be used to calculate energy yield from arrays which employ both uniform and non-uniform spacing between turbines, with greater yields being possible when changing the locations of specific turbines. Modelling indicates that increases in yield of up to 30% can be achieved.

4 INNOVATIVE ANCHORS FOR FLOATING DEVICES

These solutions offer lower CAPEX, lower material usage, quicker installation time and lower OPEX throughout the lifetime of a floating TS project in comparison to gravity based and grouted anchors.

Significant CAPEX costs can be avoided through the use of rock bolt anchors due to the huge reduction in material required to support a given mooring load. A one tonne grout-free anchor can support a mooring load of around 200t while having far smaller mass and spatial requirements

Environmental impact is also reduced compared to grouted connections as these anchors are removable at the end of their life and leave no footprint after a TS project has been decommissioned.

5 STEP CHANGE IN RATED GENERATOR POWER

Increasing the rated power within a given rotor diameter increases the amount of energy that is produced at a particular rated flow speed regardless of increases in rotor diameter. This will lead to CAPEX increases due to the larger generator and higher rating of required power electronics.

Both cost and mass scaling, however, are non-linear so larger devices of the same asset class will be more material-efficient and will be favourable when looking at metrics like rated capacity per tonne.

6 CONTROLLERS

Controllers are comprised of electrical control strategy algorithms that bring about a desired performance profile for a given generation asset. They allow more efficient turbine and array operation, as well as the ability to operate in more extreme conditions.

The problem with many previous control strategies was that the load reduction implemented also significantly reduced turbine yield.

Looking to the present, the control strategies that are currently being developed in academia can reduce loading while minimising the bearing that this has on yield across the full range of flow speeds that a turbine may encounter.

7 OPTIMISED FOUNDATIONS FOR FIXED DEVICES

Gravity based foundations require significant amounts of concrete and

steel and as a result, are sub-optimal in terms of their design and material efficiency. Due to the size and mass of gravity base foundations they are often transported to site on large, expensive installation vessels, thus increasing installation costs.

Monopile based foundations for fixed bottom devices are the most promising alternative solution to gravity bases at present, with such a solution requires far less material.

Beyond monopile foundations, a range of other concepts have been investigated for fixed bottom TS devices including streamlined twin turbine foundations which offer reduced hydrodynamic loading on turbines which minimised structural requirements while featuring fixation subsystems to maximise yields from oncoming tidal flows.

8 WET MATE CONNECTORS

Wet mates are used to enable subsea connection of individual turbines to wider turbine arrays and export cables. They offer several advantages against dry mate connectors which include removing the need to bring cables



Rock Bolt Swift Anchors

to the surface for connection or disconnection, thus reducing time and costs associated with installation and maintenance.

Because of quicker connection and disconnection, vessel hire periods can be reduced which allow larger weather windows in which it is safe to operate offshore. When considering wet mate installation versus that of dry mates, wet mate installation costs are estimated to be 65% lower.

At present many wet mates are highly bespoke and this results in far higher per unit costs, with designs often only being suitable for one turbine model.

Low order volume is another area which results in many TS developers having to settle for sub-optimal wet mate designs.

Wet mate suppliers are insistent on sticking to the “classic” voltage levels (eg, 6.6kV, 10kV). The cost of manufacture is reduced by sticking to standardised voltage levels

9 CABLE CONDITION MONITORING

As larger arrays come online in the later part of the 2020s, a better understanding of cable prognosis and failure modes to minimise downtime will be essential in reducing project OPEX while maximising generation hours for operators in the future.

While far less cable is used in TS projects due to the shorter distances to shore and smaller scale of projects compared to offshore wind, the site conditions are highly dynamic. They can potentially cause cable friction with the seabed and thus, wear.

10 PITCH CONTROL
Pitch control systems alter a turbine’s blade angle in relation to the tidal flow. This can be executed to maximise power generation, minimise loading, and assisting turbine braking systems.

Pitch control systems bear some similarity to the electrical control strategies but instead of controlling interactions between generator electrical output and rotor torque; pitch control focuses on the angle at which each turbine blade operates.

The simplest method of pitch control is collective pitch control where all turbine blades collectively

pitch together to the same angle, whereas individual pitch control (IPC) involves independently pitching each blade to its own angle.

When comparing fixed and floating devices, optimal IPC control strategies can vary. When successfully implemented on a TS turbine, optimised IPC hardware can play a role in maximising swept area for a given nacelle mass.

By increasing turbine yield, higher capacity factors are achieved, with each 1% increase in lifetime capacity factor resulting in a LCoE decrease of around 1% .

NOVA INNOVATION



Nova turbine

Nova Innovation has developed that M100D and M500D models. Three M100D were installed in Shetland in 2020 and have been powering the grid.

The M500 tidal turbine, named ‘EUnice’ was also deployed in Shetland.

The company is currently involved in SeaStar, a 4 MW tidal energy farm that will be home to the largest number of tidal turbines in the world.

Nova will include sixteen M100D tidal stream turbines at the EMEC Fall of Warness test site, Orkney.

ORBITAL

In 2021, Orbital Marine Power (Orbital) launched O2, perhaps the world’s most powerful tidal turbine. The technology is based on a floating platform with twin turbines fixed to retractable legs. This means that the tidal turbine can be positioned in the most energetic parts of the water flow.

The company has been recently confirmed as the technology partner for Orcas Power & Light Cooperative (OPALCO)’s proposed site off Blakely Island in Rosario Strait, Washington State.

Building on a memorandum of understanding (MOU) signed between Orbital and OPALCO in 2021, this latest update follows the US Department of Energy (DOE) shortlisting two marine energy

projects to receive \$6 million for the development of a tidal energy research, development, and demonstration pilot site. At the end of the Phase 1 term, one of the two organisations will be funded to move forward with development of a full project.

If the chosen organisation at the end of the ten-month process, OPALCO proposes deployment of an Orbital O2 floating tidal energy turbine in Rosario Strait in the San Juan Islands to provide a local power supply and further assessment will be completed as part of Phase 1.

Orbital has also confirmed the building and launching of the next generation of Orbital floating tidal turbines in Nigg, Scotland. It has selected Global Energy

Group as preferred supplier to lead the manufacture and assembly of turbines for the company’s initial Orkney projects which have secured contracts under the UK Government’s Contract for Difference auction rounds 4 and 5.

It is anticipated that turbine manufacture will start at Global Energy Group’s Port of Nigg facility on the Cromarty Firth, later this year with first power expected from the Orkney connected projects in 2026.

In keeping with the company’s vision of using a predominantly UK based supply chain for the manufacture and installation of its tidal projects, Orbital expects to demonstrate an unparalleled level of UK job creation on a per MW basis with the delivery of its CfD projects.



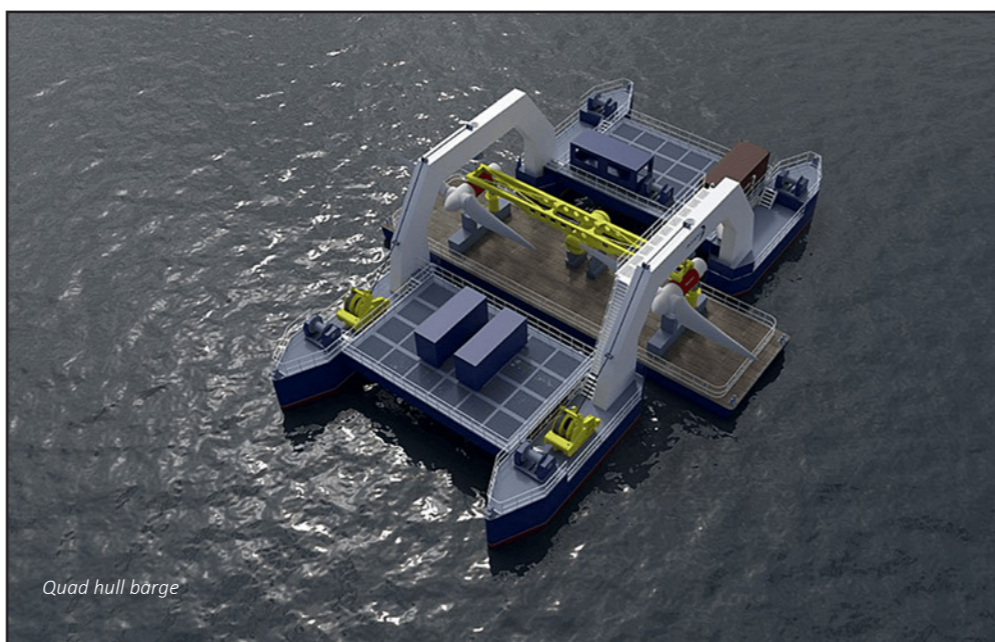
Orbital Marine Power's O2

HYDROWING

HydroWing has designed an innovative new barge which will help drive down the cost of installation and maintenance for its tidal stream array technology.

HydroWing is designed to be a cost-effective and scalable solution to tidal stream energy generation. It was the largest tidal stream project in Wales to be successful in the UK government's latest Contracts for Difference round, having been awarded a 10MW project at the Morlais tidal energy site in Anglesey.

HydroWing technology offers a modular, reliable solution, based on its unique patented design. The wing system streamlines operations and maintenance by allowing for removal of sets of tidal energy turbines without the need to remove or work on the foundations.



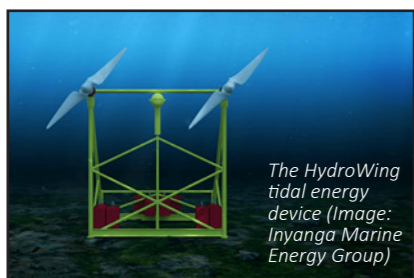
Quad hull barge

Commercialisation of the tidal energy sector has so far been held back by high operations and maintenance costs. HydroWing's next generation technology addresses that challenge head on. The new Quad Hull Barge is the latest innovation to the HydroWing system, which further increases productivity and drives down costs.

Richard Parkinson, MD of Inyanga Marine Energy Group, said "Offshore

construction vessel availability is very weak with expensive day rates.

"By using four hulls connected by crossbeams and arch support beams, the limit to load width is dramatically increased. Where commercial vessels would typically need to place the load onto the deck with little to no overhang of the load, the Quad Hull Barge locks the load after lifting to the arch. This reduces offshore handling and makes the operation much safer."

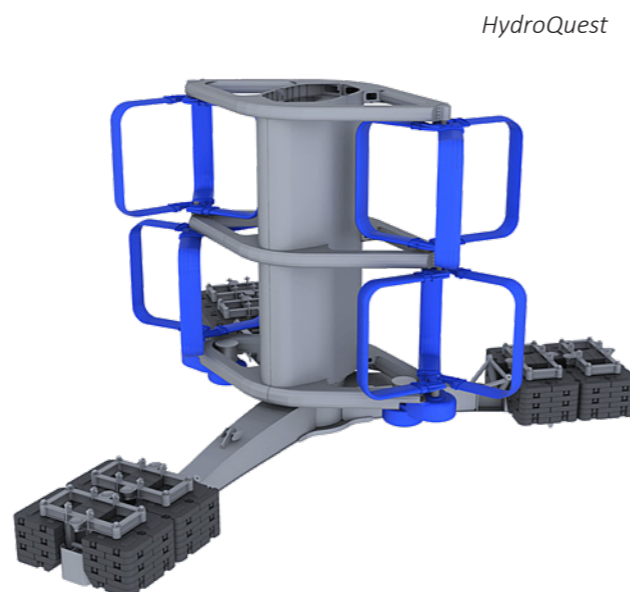


The HydroWing tidal energy device (Image: Inyanga Marine Energy Group)

HYDROQUEST

French tidal stream company HydroQuest has developed the second generation of turbine, HQ 2.5, building on the reliability demonstrated by its prototype, while increasing the yield. Its weight is also reduced in order to facilitate its deployment and to lower operational expenditures.

Hydroquest will continue the demonstration and technological maturation of sub-sea tidal energy, maintaining the good positioning of French technologies on a growing international market.



HydroQuest

MINESTO DRAGON 12



Dragon 12

Since Minesto installed the tidal kite Dragon 12 at the site in Vestmanna earlier this year, it has enjoyed a trouble-free three-month period of testing and electricity production, generating valuable results and data to underline commercial readiness of Dragon Class technology at commercial scale. Notably, real test data from the commercial scale D12 is now available to customers and is used to show autonomous functionality, product performance, and service interval analysis. The large Dragon 12 (1.2 MW) is accompanied by a smaller Dragon 4 (100kW) which means that two systems are installed and grid-connected in parallel.

EMEC

EMEC is the world's first and leading wave and tidal energy testing facility and has hosted more ocean energy technologies than anywhere else in the world.

The UK Government has announced a new £4.6 million support package for the UK's islands, £3 million of which will be awarded to the Orkney-based European Marine Energy Centre (EMEC) over two years.

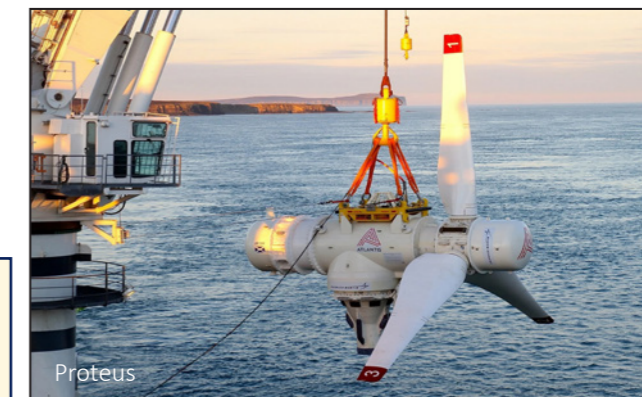
EMEC was set up as a not-for-profit test facility in 2003 following a recommendation by the House of Commons Science and Technology Committee to kick start a wave and tidal energy sector in the UK. An economic impact assessment spanning two decades of EMEC's operations values impact of the test centre to the UK economy at £370 million; £263 million of that was accrued in Scotland, and half of that, £130 million, in the Orkney Islands where EMEC is based.

BLYTH RENEWABLE ENERGY CENTRE

ORE Catapult's National Renewable Energy Centre, Blyth is the UK's leading Technology Innovation and Research centre. Since 2013, it has been used for bringing 148 products and services to market and partnered over 650 research and development projects. The facility has supported over 1350 small to medium enterprises. Blyth was the testing site of Proteus' AR1000 and AR1500 fixed bottom turbine technology.

PROTEUS

Proteus Marine Renewables was established in 2022, building on the foundations established by its predecessors Marine Current Turbines, and Atlantis. Its technologies have generated 22GWh which amounts to approximately one quarter of UK/EU's total output to date. Following successful testing and lessons learned, in 2017 one AR1500 was subsequently successfully deployed at the MeyGen site in the Pentland Firth, Scotland.



Proteus

The modular turbine system allowing broad flexibility in supply chain and assembly options, is customisable up to 3MW output with large rotor diameters, optimised to suit local environmental conditions, or to specific customer requirements, such as the AR500 system as Japan's first permitted tidal system, installed as a demonstration unit in January 2021.

The drive for a lower cost of energy has led to the design of the AR 3000, producing double the yield with increases in rotor swept area of 80%, with plans to deploy this in France, Scotland as soon as 2026. With a third party validated cost of energy reduction path and its own in-house expertise in marine construction, Proteus provides a holistic marine energy solution.



FALCON

Halifax, Nova Scotia-based Occurrent Power, formerly known as BigMoon Power, has appointed Jay McKenna as its new CEO. The company will manage BigMoon's original 500kW, patented surface-based device *Falcon* which commenced trials late 2022. It has enough to power for about 500 homes.

The Falcon has been described as a 21st-century adaptation of very old technology in the form of a Roman paddle wheel. Each unit consists of a large wheel suspended between the pontoons of a 30m barge anchored to the ocean floor. The barge can swivel to remain facing the current.

The system hopes to convert tidal energy into renewable electricity, with minimal impact on sea life and the ocean environment. A key design feature of Occurrent's tidal turbines are easy deployment and maintenance.

The equipment has to be robust to withstand the harsh conditions of a saltwater environment and in some of the highest tides in the world. It has

to be protected from debris while minimising the impact on fish and marine mammals. BigMoon spent about \$20 million on research and development over six years.

"Our ocean tides carry up to 800 terawatt-hours of energy per year, enough to power more than 50 million homes or 120 million electric vehicles," said McKenna. "We see real promise in converting this potential into cost competitive zero emission power for coastal communities."

Occurrent Power's first facility, under an existing power purchase agreement with Nova Scotia Power, will be at the Fundy Ocean Research Centre for Energy (FORCE) in the Minas Passage, Bay of Fundy. Occurrent Power plans to deploy additional facilities to meet the clean power needs of tens of thousands of households across Atlantic Canada and North America.

WATTS OCCURRENT?

In 2019, Big Moon Power signed an agreement to participate in a tidal

energy scheme in North Wales after signing an agreement with Morlais. Morlais is run by social enterprise company Menter Môn. It manages an area of 35Km² of the seabed near Ynys Cybi (Holy Island), Ynys Môn (Anglesey). The scheme has the potential to generate up to 240MW of low carbon clean electricity.

Earlier this year, Morlais, officially handed over the substation to site owner The move signals the successful delivery of the first phase of the project within the timeframe and to budget.

Construction of the substation is a key part of the infrastructure for the new development and Completion means the project can move to the next phase as it prepares for the deployment of turbines in the sea from 2026. Morlais will install the necessary infrastructure in the zone. It will then rent a berth to turbine development companies so they can use tidal energy to generate electricity.

THANK YOU

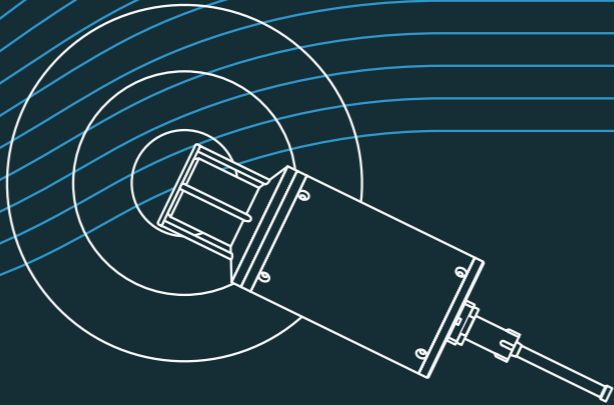
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