MARINE TECHNOLOGY
REPORTER

June 2018

www.marinetechnologynews.com

Subsea Defense

Duane Fotheringham, Hydroid, discusses AUV technology to meet subsea military needs

Voices

Matt Hodson
Marine Hub Cornwall

Energy

Robots for Renewables

Tech Talk

Tentacle Autonomous LARS

Volume 61 Number 5

NAVIGATOR

A one man navigation and sonar reconnaissance unit

SHARK MARINE TECHNOLOGIES INC.

The Navigator, a second generation Sonar Imaging and Navigation system, designed by Shark Marine primarily for MCM and SAR use.

Proven

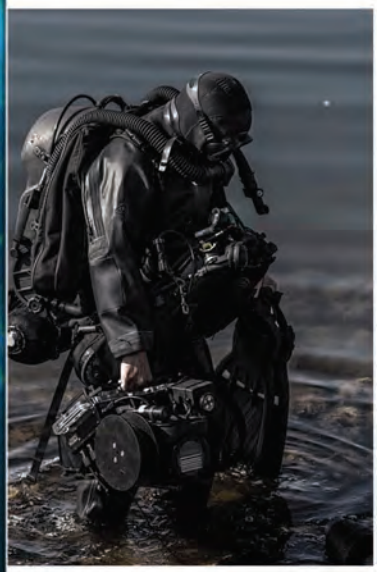
Tested and proven, the Navigator is the trusted choice of 17 Navies, as well as Law Enforcement, Search and Rescue Teams and Scientific Researchers spanning the globe. The Navigator has become a critical part of the Standard Kit and has reshaped SOPs. The modularity of the system and numerous advanced sensors available allow the Navigator be to become a force multiplier, enabling smaller groups to cover more ground efficiently with increased safety.

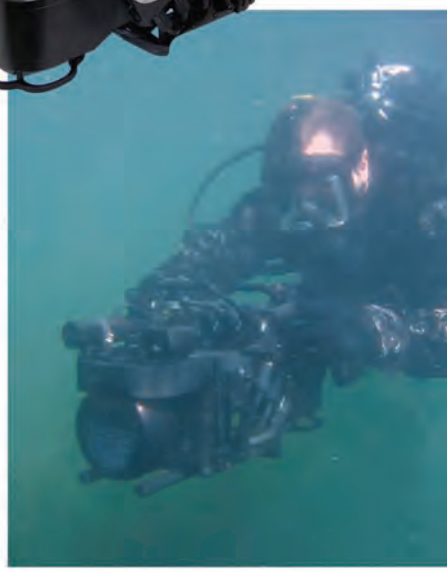
Mission Ready

The Navigator is the most modular system of its kind, enabling it to be quickly configured for any application.

Intuitive

Shark Marine's DiveLog software controls all operations of the navigator and its accessories, operators need only learn one software to master all their equipment.





www.sharkmarine.com sales@sharkmarine.com Ph: (905) 687 6672

Qinertia

The Next-generation INS/GNSS Post-processing Software

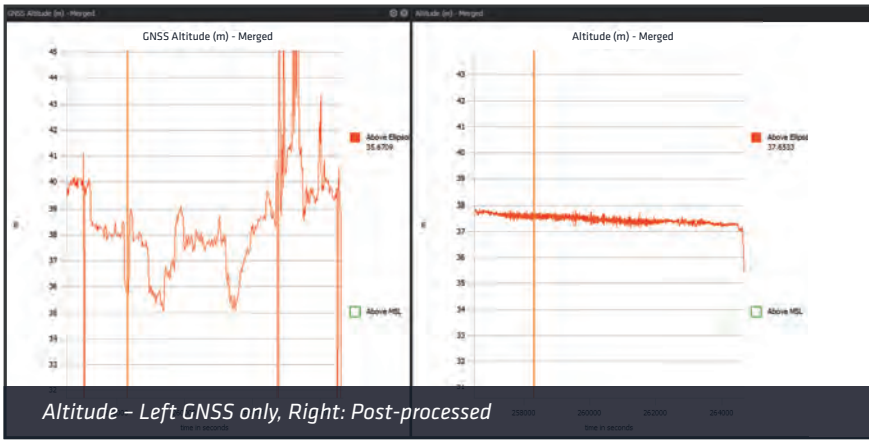
Quality: *Green -> centimetric position; Blue -> decimetric < 30cms; Red -> Raw GNSS data*

SURVEYING UNDER BRIDGES MADE EASY

This survey has been done with an APOGEE INS under very challenging conditions for the GNSS receiver (red dots).

The boat is crossing multiple times three large bridges including one made of steel.

With Qinertia and its unique 100% in-house GNSS/INS tightly coupled forward / backward processing, data collected under the bridges are fully exploitable (blue / green trajectory).



Altitude – Left GNSS only, Right: Post-processed

The Fastest PPK Software

Log duration: 2h15
Processing Time: < 2 mins

Long GNSS Outages Handling

Example: up to 80 seconds *outages and multi-path effects*
95% positions < 2 cms
Max error < 30 cms

Easy & Powerful Exporter

Easy export to third party software (SBET/ ASCII)

Many thanks to Hydro Systems Development (HSD Japan) for their kind collaboration.

Full data available upon request at marketing@sbg-systems.com
www.sbg-systems.com

SBG SYSTEMS

June 2018
Volume 61 • Number 5

Contents

Marine Hub Cornwall

Rovco

Hydroid

Voices

14 Matt Hodson
Matt Hodson leads Marine Hub Cornwall, helping to showcase the UK's southwest coast as a world-class center for marine technology and innovation.
By MTR Staff

Tech Talk

20 Autonomous LARS
A walk through the development of Kraken's Tentacle Autonomous LARS.
By David Shea

Renewables

26 Robots for Renewables
As the offshore renewables fleet grows, so too does the use of robotics and autonomous systems, as cost-reduction comes into focus.
By Elaine Maslin

Defense

34 Fotheringham at the Helm
Hydroid is a ubiquitous name in subsea defense, with nearly 70% of its business coming from the sector. It is also one of the longest-tenured AUV makers. Duane Fotheringham, president and chairman of the board, discusses the future.
By Greg Trauthwein

UUVs

42 Taking UUVs Faster, Further, Deeper
Born in 2015, Riptide was started by industry veterans with an idea to make UUVs more accessible and successful.
By Justin Manley & Jeff Smith

4 Editor's Note
6 Authors in this Edition
8 Trending
50 Tech File: Product of the Month
54 New Tech
58 People & Company News
63 Classified
64 Advertiser's Index

REMUS

ONE VEHICLE. MANY MISSIONS.

The reputation of our REMUS vehicles speaks for itself. Low cost and low risk, our combat-proven vehicles can take on any mission – from finding mines to mapping the ocean floor to search and recovery.

HYDROID

A KONGSBERG COMPANY

Intelligent Marine Robots You Can Rely On

To learn more, visit **HYDROID.COM**

Cover Photo: Hydroid

www.marinetechnologynews.com

NEW YORK
118 E. 25th St., New York, NY 10010
Tel: (212) 477-6700; Fax: (212) 254-6271

FLORIDA
215 NW 3rd St., Boynton Beach, FL 33435
Tel: (561) 732-4368; Fax: (561) 732-6984

Editorial

Gregory R. Trauthwein
Associate Publisher & Editor
Email: trauthwein@marinelink.com

On a recent run up the coast to Massachusetts I was afforded the opportunity to stop in and visit **Duane Fotheringham**, president and chairman of the board of Hydroid. Throughout my 25+ years covering all matters maritime, I have found that there is no better way to really get the feel for a company than visiting them where they work. The visit to Hydroid was particularly telling for me, because the last time I had stopped in personally was almost a decade ago, when **Chris von Alt** was at the helm of the company he founded, and the company was dramatically different.

The visit with Hydroid was perfectly timed for the June 2018 edition, our focus on defense. Defense, and in particular the U.S. Navy, has always been a tech driver in this sector, arguably no more vibrant than today as the U.S. faces a host of continually evolving asymmetric threats, and the push for autonomous systems subsea is finally catching up with developments on the land and in the air. Fotheringham, a former U.S. navy officer and fast-attack submarine driver, provides a nice balance of insight on how evolving AUV technology is meeting evolving military mission needs, starting on page 34.

Looking ahead, the next edition of *MTR* is our **13th Annual "MTR100" edition**, a look at 100 innovative companies and people in this subsea space. The MTR100 has taken on a life of its own since we started it in 2006, and each and every year since I give sincere thanks that I didn't go with my original impulse to make it the "MTR200"! The application for inclusion in the MTR100 is now open, and in this edition you will see a few innovative twists from our editorial team, including for the first time a naming of the "Top10". I look forward to your applications for this, the biggest and best awards edition in the subsea sector. To apply visit: **http://mtr100.marinetechnologynews.com/**

MARINE TECHNOLOGY REPORTER
www.marinetechnologynews.com
Vol. 61 *No. 5*
ISSN 1559-7415
USPS# 023-276
118 East 25th Street,
New York, NY 10010
tel: (212) 477-6700
fax: (212) 254-6271

Marine Technology Reporter (ISSN 1559-7415) is published monthly except for February, August, and December by New Wave Media, 118 E. 25th St., New York, NY 10010-1062. Periodicals Postage Paid at New York, NY and additional mailing offices.

POSTMASTER: Send all UAA to CFS. NON-POSTAL AND MILITARY FACILITIES send address corrections to Marine Technology Reporter, 850 Montauk Hwy., #867, Bayport, NY 11705.

Get Mission-Critical Data Through In the Most Demanding Environments

BIRNS has been proudly supplying high performance subsea military products since 1957, and we've been innovating technology to anticipate the changing needs of the defense industry ever since. Today our advanced, field-proven 6km-rated electro-optical BIRNS Millennium™ cable assemblies provide massive data rates in a tiny footprint for the most demanding subsea defense applications. These robust assemblies feature low insertion losses (typical .1dB SM, .25dB MM) and can be customized to include all titanium components for the ultimate in corrosion resistance.

Tailored Connectivity Solutions for Undersea Defense

BIRNS®

High Performance . . .
Under Pressure®

www.birns.com

BIRNS is NAVSEA PRO-020 Certified;
Our Quality Management System is
ISO 9001:2008 Certified by DNV GL

Authors & Contributors

Haun

Mulligan

Manley

Maslin

Shea

Smith

Haun

Eric is MTR's Managing Editor, as well as New Wave Media's Web Editor for MarineTechnologyNews.com.

Manley

Justin Manley is a technologist and executive with experience in startup, public corporation, academic, and public sectors. After professional roles at MIT, supporting NOAA and in the private sector he founded Just Innovation Inc. in 2015 to support a variety of clients with a focus on unmanned and undersea systems.

Maslin

Elaine Maslin is an offshore upstream and renewables focused journalist, based in Scotland, covering technologies, from well intervention and asset integrity to subsea robotics and wave energy.

Mulligan

Tom Mulligan is MTR's science and technology writer based in Ireland. Mulligan was born in London in 1958 and grew up in Manchester, England. He graduated Trinity College Dublin in 1979 with a BA Hons Degree in Natural Sciences (Chemistry). He obtained his Masters Degree in Industrial Chemistry from the University of Limerick in 1988.

Shea

David Shea is the Vice President of Engineering for Kraken Robotic Systems Inc. David has over 10 years of experience designing, building and operating next generation unmanned underwater vehicles and sonar systems. He has been involved in a number of high profile underwater search operations, including the Franklin Expedition in 2014 (resulting in the discovery of HMS Erebus) and the Raise The Arrow Expedition in 2017 (resulting in discovery of 2 of the 9 Avro Arrow models). David holds a BEng in Electrical Engineering from the University of Victoria (UVic).

Smith

Jeff Smith is the CEO of Riptide Autonomous Solutions. He has over 20 years experience in technical management, program management, executive management, Navy Program Development, and UUV development. He founded Riptide in late 2015 after having been COO of Bluefin Robotics.

EMPOWERING

WORLD LEADER IN UNDERWATER e-ROBOTIC SYSTEMS

SAAB

SAAB SEAEYE

THE FUTURE IS ELECTRIC

AUV Tracking System Tested in Loch Ness

https://www.marinetechnologynews.com/news/tracking-system-tested-560766

A collaborative research project called Autonomous Surface and Sub-surface Survey System (ASSSS) aims to deliver an integrated system to provide a means of conducting low cost, shore based, full water column marine surveys using multiple unmanned systems. The project, part funded by Innovate UK, hopes to encourage wider adoption of unmanned systems.

The project is being led by a U.K. based developer of unmanned and autonomous marine systems, ASV Global. It combines the advantages of autonomous underwater vehicles (AUVs) and autonomous surface vehicles (ASVs) to further data gathering opportunities. The ASV follows the AUV in order to provide position updates to improve dead reckoning while the AUV provides status updates and basic survey information back to the ASV to be transmitted to shore.

The project team involving software company SeeByte; provider of underwater acoustic, inertial, optical and sonar technology Sonardyne; and the marine science research and technology institution National Oceanography Centre (NOC) are carrying out trials in Loch Ness in the Scottish Highlands this week (May 14, 2018).

The latest round of testing builds upon the capability demonstrated in two previous trials in 2017.

The initial trial in May 2017 saw the C-Worker 5 ASV successfully communicate with, and track, the ALR over a six-day period. Sonardyne provided a comprehensive suite of underwater positioning, communications and imaging technology for the Autosub Long Range (ALR) AUV developed by NOC.

Trials in September 2017 took place in Plymouth over 13 days and included night-time operations. These trials focused on gathering solstice side scan data for sea floor mapping using the ALR and transmitting real-time snippets of the data containing interesting features back to the ASV using the BlueComm 200 underwater optical communications system.

The follow and search behaviors executed by the C-Worker 5 could be configured to follow the target at an offset to the course and can also be configured to respond to different target sources such as an automatic identification system (AIS) which was also seen in this set of trials.

Other successes during this demo included the launch and recovery of the ASV and AUV from a 6T SWL hydraulic crane on MTS Terramare, a 26m converted landing craft. This helped to prove the application and capability of the ASSSS system for smaller survey operations.

According to ASV Global, the main objective of this project is to accelerate the wider adoption of unmanned systems and enable long term, low-cost survey and monitoring operations for offshore energy applications, deep sea mining prospecting and Carbon Capture and Storage (CCS) monitoring.

There will also be a consequential reduction in the need to place humans in dangerous environments and a greater acceptability of unmanned systems by operators and regulators, the company said, adding adoption of the technology is likely to spawn opportunities in adjacent market sectors and facilitate cross domain technology transfer.

Photos: ASV Global

RS AQUA

WaveRadar REX

Wave, Sea Level, and Air Gap Sensor

STABLE. PROVEN. RELIABLE.

The perfect medium for the extreme demands of harsh offshore, maritime, and coastal environments.

Applications

- Safety status monitoring
- Structural monitoring
- Weather forecasting
- Water level observations
- Air gap studies
- Motion-compensated wave & draft measurement from ships

EMERSON

www.rsaqua.co.uk

RS AQUA

USCG Tests Enviro Friendly Buoy Moorings

The U.S. Coast Guard uses navigational buoys to direct water traffic and to protect vulnerable benthic ecosystems such as seagrass communities and coral reefs in U.S. waters. However, most buoys are currently attached to the seafloor by concrete anchors, also called sinkers, and heavy metal chains that can have a significant impact on marine life. Sinkers can damage life on the seafloor under their heavy footprint, and when the connecting chains are lax, they can scrape off seagrasses, seaweeds and corals around the sinkers as waves and wind push the buoys around. The Coast Guard has been struggling to find a solution for more than 20 years, and about two years ago, the service reached out to the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) for help. Subsequently, S&T organized a prize competition in January 2016.

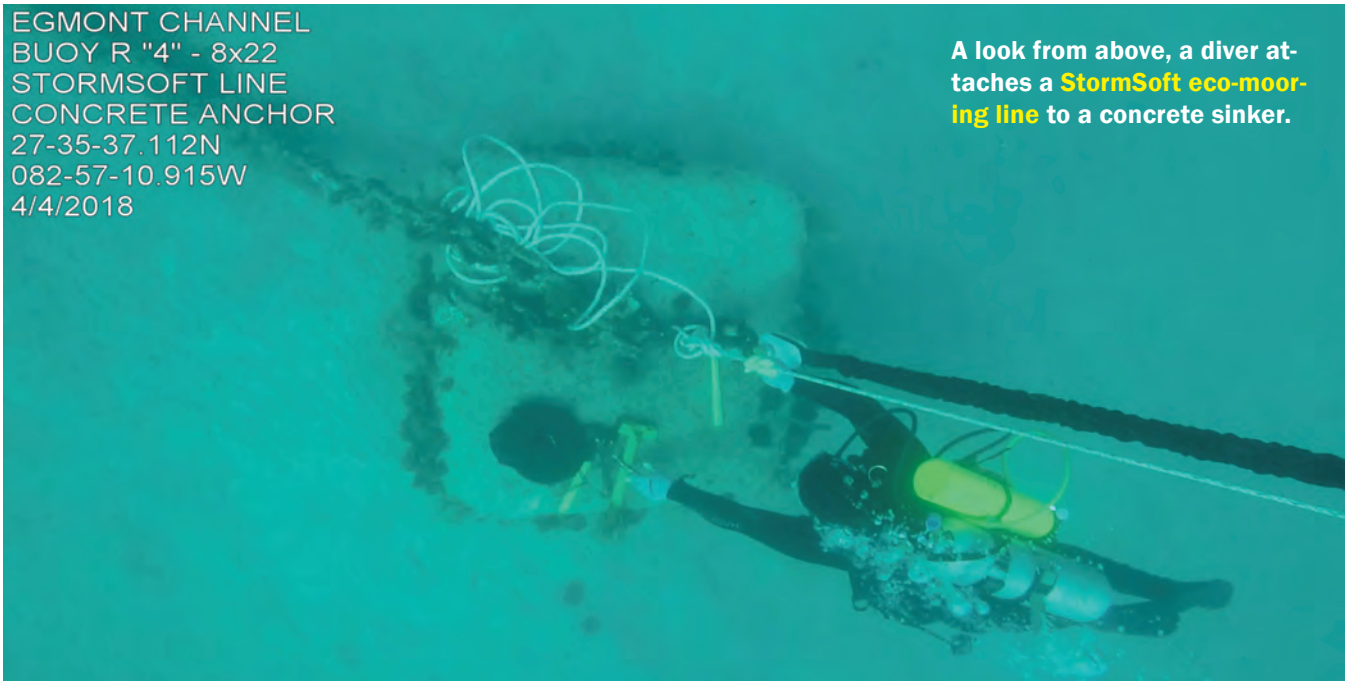
From among the proposals, S&T found a potential solution to the problem in a simple, but effective, buoy mooring system. Instead of a concrete sinker, Cole Keaoulu Santos, an innovator from Hawaii, proposed a narrow screw anchor; instead of a heavy metal chain, he suggested an elastic rope to prevent scraping of the ocean floor. "We consider DHS S&T a key partner to introducing technology and innovation into the Coast Guard. Leveraging the DHS public prize competitions allows us to more effectively reach out to the public and their good ideas to help address Coast Guard challenges," said Bert Macesker, Executive Director at Research and Development Center (RDC). "Building on the success of this environmentally-friendly buoy mooring effort, we are launching our second public prize competition with DHS S&T to enhance the detection of persons in the water."

In April, the RDC embarked on a two-year experiment to test several different types of mooring systems, inspired by Santo's concepts. The RDC, using U.S. Coast Guard cutter Joshua Appleby, a 175-ft. Keeper Class coastal buoy tender, deployed five buoy mooring systems near the coast of St. Petersburg, Florida. There, the buoys' impact on the ocean floor and ability to withstand the elements while staying securely moored will be evaluated. The results will determine if the moorings are fit to be adopted on a broader scale.

"The Coast Guard, as marine environmental stewards, wanted the RDC to research minimally invasive methods for anchoring and mooring marker buoys in environmentally sensitive areas," said James Fletcher, Chief of RDC's Environment and Waterways Branch; one of the Branch's missions is environmental protection.

Coral reefs and seagrasses are among the most biologically diverse ocean ecosystems; they provide important habitat for marine life – manatees, sea turtles and a variety of fish and invertebrates. An environmentally sensitive mooring system can help preserve these ecosystems.

The reason for testing different types of mooring systems is to find the most durable and efficient one. The Coast Guard decided to install two types of anchors at water depths of 38 to 48 feet—the traditional concrete sinker and the helix (screw). Three types of mooring lines are being used – StormSoft, Hazelett and Supflex.



A look from above, a diver attaches a StormSoft eco-mooring line to a concrete sinker.

Photos: U.S. Coast Guard

"RDC researchers deployed different combinations and mooring lines to evaluate a wide array of potential solutions," said Danielle Elam who is a project manager at the Environment and Waterways Branch. "Instead of building a whole new system, maybe we could just change the mooring line. If this works, it might save us money, it might save us time. Or we may need to change the entire system."

Using helical anchors and elastic mooring lines is not new. Recreational boaters have been using the concept, called eco-mooring, for some time.

"So, the Coast Guard is wondering 'Would this work for us?'" Elam said. "We are looking right now to change the footprint of our anchors. How much damage can be made by a huge 3,000-pound block of concrete versus the small helical anchor? When there is big storm and the sinker gets picked up and is dragged along the seabed, how much damage can happen?"

For the experiment, the Coast Guard chose two navigation channels with a bare sandy floor suitable for the helix anchors and "so that we don't have any environmental concerns for using the concrete anchors," said Fletcher. "If we are in an environmentally sensitive area, we do prefer to use the helix anchor over the concrete."

In early April, for two consecutive days, the cutter crew and dive team worked tirelessly to complete their mission. The first day they replaced the metal chains with one StormSoft and one Hazelett mooring line models, and on the next day – with two StormSoft and one Supflex.

At first, the plan was to attach the mooring lines to two concrete sinkers and three helix anchors. However, due to technical difficulties, the divers were only able to screw one helix anchor to the seafloor. The rest of the lines were attached to concrete. The Coast Guard hopes to retrofit two of the sinkers with helix anchors during one of the future monitoring visits.

For the next two years, the Coast Guard will visit the buoy moorings every three months to monitor their durability. The dive team will document the condition of each mooring line and will provide photographic and video evidence.

"The Coast Guard changes the chains every two years because of rust," said Elam. "We are trying to see if these lines last as long as the current chains."

When the testing period is over, the Coast Guard will prepare a final report of the eco-friendly buoy moorings to support future decisions.

"The Coast Guard is very conscious to protect the environment, so we are willing to do these experiments, even if there is a little bit of a risk involved to their success, to find a better way to protect the environment and minimize harmful impacts," said Fletcher.

Photos: MacArtney

The wind turbine nacelle and hub interface with the generator rotation tool.

MacArtney Supplies for Siemens Gamesa

The generator rotation tool (GRT) is designed to create efficient solutions for long-term storage of nacelles and helps ensure max lifespan of turbines. The employment of the GRT has turned out to be an important milestone for the logistics function of Siemens Gamesa. Having been striving to create efficient solutions for long-term storage, Siemens Gamesa has included a GRT in their portfolio with the potential to ensure cost reduction and help ensure max lifespan of their turbines.

The nacelles are subject to long-term storage and therefore require maintenance to prevent bearing degradation during standstill. If not regularly rotated, the main bearings may suffer corrosion and quality damage, for which reason keeping components well-lubricated at all times is important.

The battery-powered and radio-controlled mobile unit supplied by MacArtney is remotely driven under the nacelle with hub and mounted generator, while the nacelle is stored on its transport frame. After correct positioning of the GRT under the generator, the fully automated process is initiated.

Equipped with embedded software and an intelligent battery package, the GRT is able to operate efficiently and silently 10 hours a day. The GRT is thus part of the equipment securing long-term storage of SWT-6.0/7.0/8.0 nacelles with generator and hub.

The sustainable and cost-effective solution provided by MacArtney contributes to lowering the total cost of energy. In general, the procedure of rotating the main bearing protects the bearing from potential corrosion during long-term storage and guarantees that the product sustains its high quality level.

Besides, the GRT improves storage conditions and fulfills a need for reducing non-conformance costs in the long run by securing the bearings before installation far better than previous, long-term storage efforts.

The GRT represents a fast, easy, and reliable method for ensuring the long-term quality of stored nacelles. Performing at least five complete 360° revolutions every 14 weeks, the GRT provides for a practice of keeping the main bearing well-lubricated as the GRT makes sure that the grease in the bearing is properly distributed.

Wavepiston Tests Renolit Films

With its "Film Instead of Paint" concept RENOLIT is exploring new horizons in the maritime sector, as the company plans to enter the renewable energy market with its films. The first step has been made with the use of the flock-film RENOLIT SEAL for an innovative enterprise in Denmark, where the company Wavepiston has developed at similarly-named wave-powered energy generation project. A steel cable is stretched between two anchored buoys. Energy collectors developed by Wavepiston are attached to this cable at intervals of five to six meters. These collectors consist of a plate and a lateral hydraulic pump. The oscillation of the waves move the plates back and forth, which in turn, pumps seawater to an onshore turbine. To achieve the greatest possible energy efficiency, substantial wave movements are needed, which experience shows are found, above all, in fishing waters.

Naturally, the Wavepiston project suffers from fouling. "Encrustation with mussels, barnacles and algae increase the weight of the plates and if they become too heavy, they sink down where the wave energy is lower" says Martin von Bülow, Wavepiston's CTO. The company invested a lot of time in researching the best anti-fouling solution, as many anti-fouling coatings contain toxins and biocides. "Especially for our project, these were totally unsuitable because in the fishing areas in which our units are preferably stationed, the use of all materials containing biocides is strictly prohibited" says von Bülow. RENOLIT's films presented an alternative; effective again biofouling and biocide-free. To perform long-term real-life tests on our concept, a test field was set up in a fishing area off the coast from Hanstholm in Denmark. The 120-m long prototype consists of eight energy collectors with four square meter and seven square meter plates. Two of these plates were coated with a RENOLIT film, namely RENOLIT SEAL. This film not only has excellent anti-fouling properties but also has a very special "flock-type" surface. "We expect the film's surface structure will increase water friction and thus lead to a higher energy gain" says Sébastien Charlés, Manager of the RENOLIT MARITIME Business Unit.

As part of the long-term test in Hanstholm, the efficiency of the different plates will be tested to determine if the filmed plates generate more energy that the non-filmed plates.

Matt Hodson
Marine Hub Cornwall

Photos: Marine Hub Cornwall

Marine Hub Cornwall are on a mission to showcase the UK's southwest coast as a world class center for marine technology and innovation. Working alongside Invest in Cornwall, which manages inward investment into the region, Marine Hub's Operations Director, Matt Hodson, explains why he believes Cornwall is best positioned to be a global hub for the marine renewable industry.

To kick off, can you give the readers a brief overview of your experience and what led you to become the Operations Director at Marine Hub?

I've spent much of my early career at sea and I'm lucky enough to have worked across a wide spectrum of areas within the marine technology industry. After 12 years being promoted through various Deck Officer roles, I became Chief Officer in the Merchant Navy in 1997. Having lived in the Cornwall my whole adult life, I returned to become Fowey's Deputy Harbour Master for a little under 11 years, investing my time in the local marine industry. At Fowey Harbour, in addition to port management duties, I developed the marine leisure business as a stand-alone business unit and played a key role in the harbour's commercial shipyard management.

From there I joined a marine operations company, Mojo Maritime, that focused almost exclusively on the fledging marine renewables market place. As Mojo's Business Development Manager, I stayed with the company during the acquisition by James Fisher and Sons and helped with the expansion from eight to 30 people, generating a quadruple turnover working in tidal energy projects, offshore wind projects, software development and vessel design and other R&D projects. There was a real sense of what could be possible with marine technology companies investing in the R&D and it's a real passion of mine.

When this position came up at Marine Hub Cornwall, I felt that it was a chance to put my money where my mouth was. I've been pretty vocal at Mojo about

what I felt was necessary to promote and grow businesses in this region, and it was a great opportunity to see that realized from the other side of the coin.

Marine Hub was launched to become the voice of marine technology innovation in Cornwall. Tell us about the project and why you are set on strengthening the region's position as a leading global technology hub.

If you look at the map of Europe and where the current offshore activities are happening, it's centered on the southern North Sea. If you start factoring what's coming down the track when you look at the potential of the Atlantic seaboard and where the tidal energy sites are likely to be, Cornwall sits bang in the middle of that activity. We are really well strategically located and the shipping lanes for all activity converge on us.

At the end of the day, the Cornish economy needs companies within the marine sector to do well, grow and to become sustainable businesses. For that to happen the public sector needs to support and has supported that vision over the years by investing in infrastructure and funding packages. The Marine Hub provides a great opportunity to really tie all of that together into one of credible voice. The number one job that we do is to shout about all these activities.

When you speak to clients from overseas, what they like about this region is that companies talk to each other, they collaborate, and they get stuff done. It is a genuine hotbed of innovation and there's some exciting things happening in Cornwall. Not a lot of people understand the capability of the region and it's important to come from a strong base if you want to talk about the great potential here. I see that as a starting point for us and I'm really excited about taking this forward.

For most of your working life you have operated in Cornwall's marine industry. How has the industry changed over the years and what is being done to prepare the region for growth in the near future

When I first moved to Cornwall there was a thriving marine scene here primarily around commercial shipping and bunkering, ship repair, fishing, marine leisure, and the port infrastructure around that. It was traditional, but even back then there were some interesting Cornish companies who were innovators for the time.

Before they were bought out by Fugro, Seacore was a Cornish company globally renowned as drillers who got the job done. Seacore worked mostly in marine civil engineering and oil and gas and were based in Gweek at the time which is a tiny little village that no one would have heard of normally. When I was at sea working for an offshore company on their cable ships I remember how the crew were talking in hush tones about these Seacore drillers. Coming from such a tiny Cornish village I wondered how they were being talked about halfway around the world, but it's because they did things differently and they did things well.

The key change however has been more about the markets and how we exploit them. Although all those traditional activities still happen today we've gone from a entrenched and declining oil and gas industry to an offshore wind industry which is really beginning to really rock, and fledgling Wave and Tidal technology. As part of that there is now a real focus in Cornwall on cost and risk reducing activities for these industries.

Another change is a blurring of what a marine technology company is. We've also got some really strong digital companies here developing products to sell to the marine sector which is probably more diverse, dynamic and innovative than it has ever been before.

Start-ups in this area have a very strong success rate in comparison to the UK average and it's an environment where they can really flourish by working closely together within business networks. Likewise, most of those companies that were starting up when I was younger have grown, been acquired, achieved investments and are still here today, which I believe is real proof in the pudding.

Since launching in February 2017, Marine Hub is now in the center of Cornwall's the marine renewable energy sector. To give readers an insight to the type of activities you are involved in, can you tell us what is a typical day is like in your role?

There is no typical day for me. My role is about understanding what the private sector is capable of and being able to match that up with how the markets are developing. I'm often visiting colleagues, stakeholders and companies across Cornwall, the U.K., and Europe to better understand where we might be able to support them.

That brings me onto the Marine-i project which is a really important component of the Marine Hub offer, and I'm involved in that for half my time. That fact that every day is different is one of the attractions of the job.

Can you tell us about the Marine-i scheme and how Marine Hub is helping to promote innovation in marine technology?

The Marine-i is a research development and innovation stimulus multi-partner project led by the University of Exeter. To put it simply, it's purpose is to help solve the market

failure of a lack of R&D activity in the SME population. We have a lot of innovative companies which are doing well, but if you look at the percentage of turnover we can do better. That is in line with the UK industrial strategy and a UK-wide mission to really look at increasing R&D activity.

We have several other projects that are happening through Invest in Cornwall that look to do similar things across aerospace, health, agriculture and space. Marine-i is focusing on the marine technology companies that are looking to create products, processes, and services for the marine industry. How do we do it? It's a combination of support from university partners including University of Exeter, University of Plymouth and also the Cornwall College Group to support these companies with research. We have the Offshore Renewable Energy Catapult with Cornwall Marine Network who link the markets and the private sector. We're also managing the Marine Challenge Fund which is a £3.91 million grant fund where we can help supply grants to support R&D projects. It's fascinating. We're seeing such a diverse range of really interesting solutions. We have around 150-160 companies in the pipeline now and it ranges from wave energy products to hybrid drive electric propulsion systems. We have people looking at tendering for offshore wind, boat landings, hydrographic survey solutions and autonomous vessels.

If we can get 100 companies being more R&D focused within the next two years on top of what we are already doing, it will make a huge difference to the industry. Those new products, processes, and services will be key in driving exponential growth in companies. I'm really passionate about it and it's what I did when I worked at Mojo. I know it works and I'm delighted to be playing my part in supporting it now at Marine Hub.

There has been a lot of investment within renewables energies in Cornwall recently. Can you give the readers a sense of the type of activities taking place, and the latest trends in the marine renewables sector?

There has been a lot of investment from the Marine Hub and our cousins at Wave Hub who are also based in Hayle Marine Renewables Business Park. The Wave Hub facility is a connected offshore renewable energy testing center. There is also testing in Falmouth Bay where we have people looking to test nursery devices and we have laboratories at the University of Exeter and Plymouth. All the infrastructure investment is in place and the key message now is that we are building on that to really focus on market-led activities enabled by these facilities. In terms of the types of activities that are taking place, I can point back to Marine-i. We are seeing real research in risk and cost reducing activities which are essential to driving down the cost of renewables. If you look at the national revenue of marine renewables, reducing cost remains crucial. Clearly any technology that is going to be cost competitive needs to have its cost reduced, and that is leading a lot of activity we are doing here.

Wave and tidal is still an untapped area in renewables that Marine Hub would like to help mature in the coming years. What is the biggest challenge to developing this resource and how is this being addressed?

The biggest challenge for wave and tidal right now is revenue support. I think it's recognised that the technologies in the wave and tidal industry are still some way away from the point that they can become commercially viable. But there is a huge amount of industrial work that goes on developing those technologies and it is a global industry. Marine Hub can play our part in the national debate on how we support those technologies moving forward, but we could also do

our bit by supporting companies that are being pragmatic about how they go around reducing that globalised cost of energy.

There are more than a few companies in Cornwall working in tidal energy and it is an area of strength here. From my experience, you're working in environments which is like no other, you having to evolve new products, methodologies and processes which are very optimized to even operate at all, let alone operate commercially.

What does Marine Hub have planned for 2018/19?

For the coming year there's a real focus on raising the awareness of what it is we do here at Marine Hub and Cornwall. There is also real focus of looking at likeminded companies elsewhere who could really benefit from being in Cornwall or being engaged with Cornwall's companies.

It's really important that we are working collectively to try to answer some of those bigger questions that will help create the market that a lot of companies can sell into, while also working at business ground level to capture more support for the companies already here.

Photos: Marine Hub Cornwall

Kraken's development of the *Tentacle Autonomous LARS*

By David Shea, Vice President of Engineering, Kraken Robotic Systems Inc.

From elephant trunks to octopus legs, nature abounds with tentacles that are adept at precise manipulation.

At Kraken Robotics, we wanted to see what nature could teach us about better manipulation methods for launching and recovering marine vehicles and equipment. Inspired by the sophisticated feedback loops and dynamic response times found in creatures such as the elephant, octopus and jellyfish—and even the occasional carnivorous plant—we undertook an 18-month research and development program into biomimetic design.

Getting into or out of the water is by far the highest-risk operation for any piece of oceanographic equipment. It involves multiple dynamic components, impacted by wave heights, vessel motions, wind direction and currents. Since equipment is delicate and costly, great care must be taken during its launch and recovery.

Kraken's Handling Systems Group, based in Dartmouth, Nova Scotia, spearheaded the R&D program. The lessons we learned, and the knowledge we acquired, culminated in the development of the Kraken Tentacle Autonomous Launch and Recovery System (ALARS).

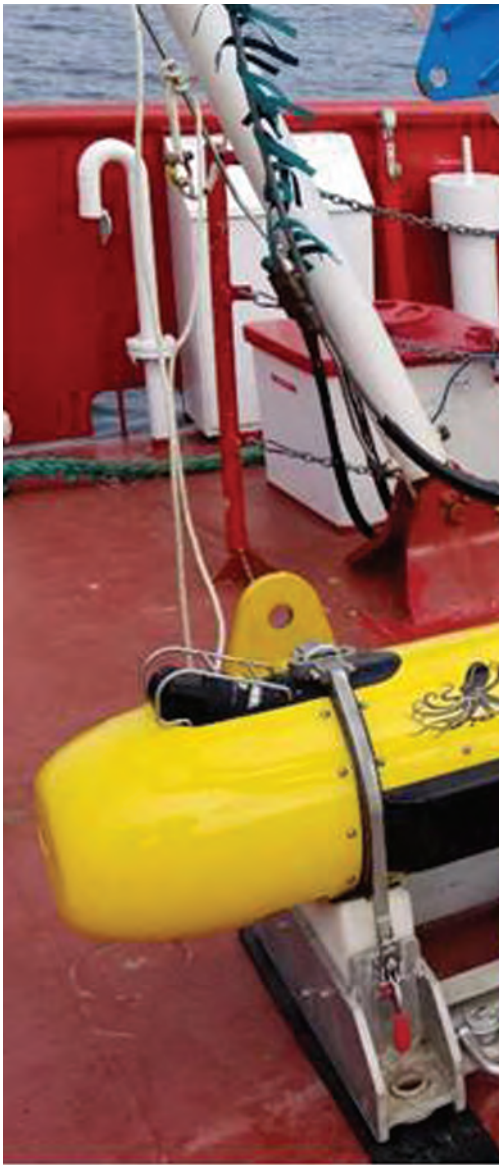
The Kraken Tentacle is not one specific system. It's a family of technologies used to implement modular, scalable launch and recovery solutions for a variety of tethered and untethered underwater vehicles. The first iteration of the Tentacle is designed for Kraken's KATFISH (Fig 1) actively stabilized towed vehicle, the main payload of which is Kraken's AquaPix Synthetic Aperture Sonar. Future versions will accommodate other vehicles as well. Following the completion of its final testing, we expect to launch the Tentacle in August, 2018

By developing an integrated sensor, platform, and LARS in house, we provide a fully operational, reliable package that's supported by a single vendor and requires only electrical power from the host vessel.

Tentacle Intelligent Winch

Designers of handling systems often go to outside manufacturers for the winch and then integrate it into their launch and recovery system. Early in the research for the Tentacle, we recognized that the winch should be the heart of the system, with the potential to provide much more than just cable pay out and reel in. As the main driver in the launch and recovery process, the winch could be designed to significantly compensate for ship motion and vehicle motion.

Like its namesake in nature, the Tentacle Intelligent Winch may look unassuming from the outside, but its true capabilities lie within. The fully integrated electronic control module hosts sophisticated algorithms for dynamic manual, semi-autonomous or fully autonomous control of the winch. The integrated motion reference unit tracks the motion of the host vessel, and the sophisticated onboard software models and pre-



Width	Depth	Height	Weight	Cable OD	Cable Capacity	Pull	Power
mm	mm	mm	kN	mm	m	kN	V
1330	1380	1550	12	8–12	2000	15	440 3Ø

Figure 1: The first iteration of the Tentacle is designed for Kraken's KATFISH.

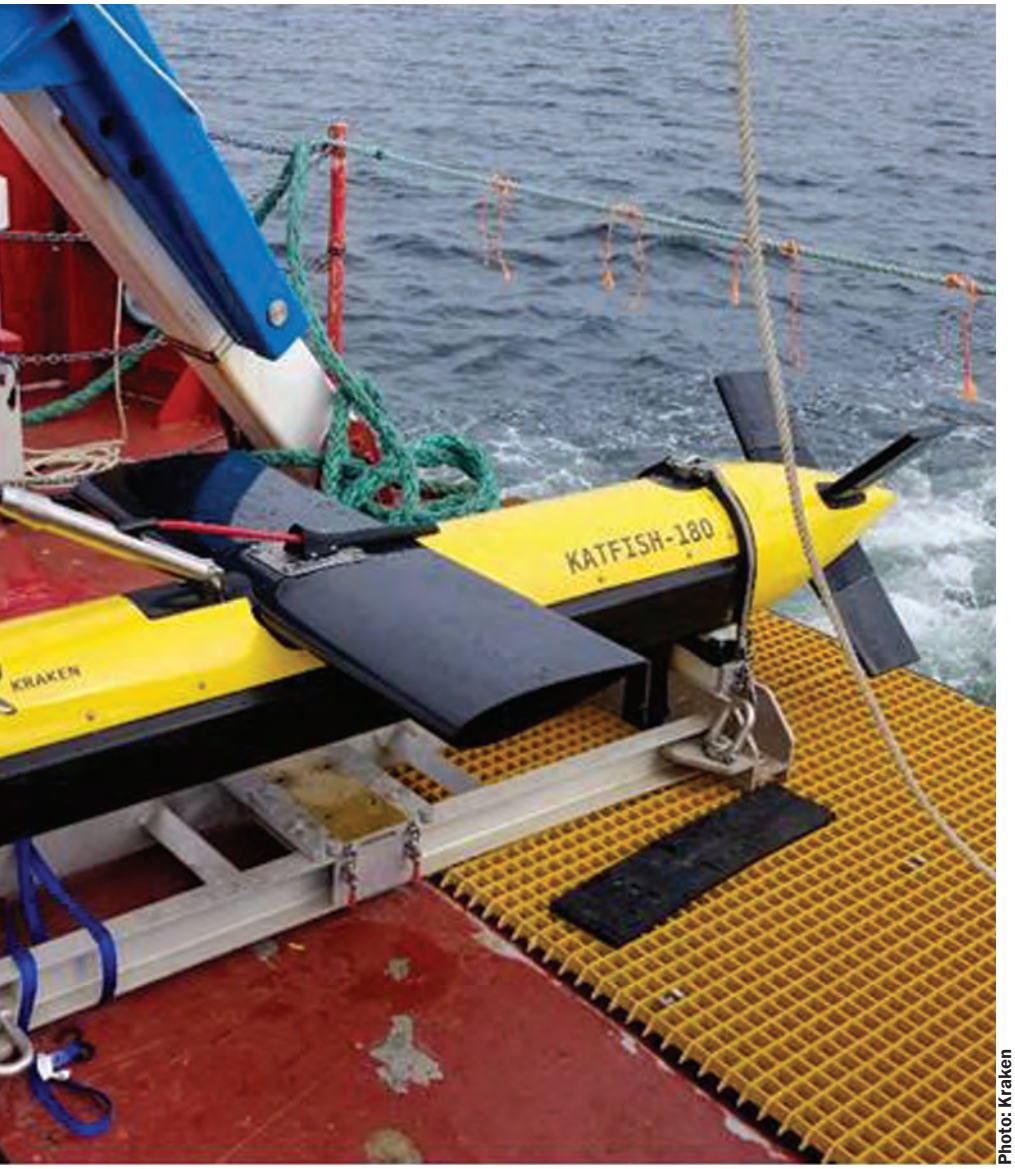


Photo: Kraken

dicts the sea state. This allows the winch to predict timing of wave peaks and troughs and optimize the variable torque on the motor to minimize input disturbances through the tow cable.

The operator can achieve manual control of the Tentacle Winch either through manual switch inputs similar to those in traditional systems, or remotely via secure Ethernet and Wi-Fi interfaces. A semi-autonomous mode allows for dynamic surge (front/back motion) and heave (up/down motion) compensation to minimize input disturbances on the tow cable even in high seas. A fully autonomous mode allows the KATFISH tow body to command the winch. As water depth increases or decreases, the KATFISH can autonomously measure the depth and command the winch to reel in or pay out. This enables increased safety, allowing for fully automated bottom-avoidance maneuvers even in dynamic environments.

The Tentacle Winch is designed to be both intelligent and robust. It meets military shock and vibration requirements of MIL-STD 901D as well as the strict international standards of Lloyd's Register and DNV-GL codes. It is a fully electric system, providing improved response times and eliminating the need for secondary hydraulic power units. And it can be integrated on a wide range of vessels, from small unmanned surface vessels to large offshore support ships.

Conditioned Reflexes

In nature, we often hear reference to reflexes and muscle memory of crea-

Figure 2: Kraken's Tentacle Intelligent Winch.

Photo: Kraken

tures, including humans. Reflexes can be broadly defined as an action or actions which occurs before the brain is consciously aware of the stimuli, and separated into two categories; withdrawal reflexes, and conditioned reflexes. In this article we will focus on the latter.

Conditioned reflexes, commonly referred to as "muscle memory", are reflexes which have been acquired as the result of experience. In the case of humans, an example is the catching of a ball; as a child, we are taught this simple action of throwing and catching through play. As an adult, when a human is thrown a ball, they will instinctively reach out to catch it before it falls to the ground, and reflexes ensure that balancing muscles are tensed, and tiny adjustments are made to compensate for the expected weight of the ball.

To return our analogy into the realm of marine equipment, we compare a human operator of a standard hydraulic winch or LARS. A young deckhand most likely requires extensive training and time at sea to understand the dynamics of vessels and interactions with the ocean. In contrast, a well-seasoned sailor with years of experience has "trained" themselves to monitor the motion of the vessel, wave conditions, the timing of the launch or recovery of equipment with the period of the waves and swell, often without thinking about it. This experience can be likened to a conditioned reflex, in which the human is performing many actions so quickly that they are executed without conscious thought.

It is precisely these biologically conditioned reflexes that we aimed to mimic in the design of the Tentacle Winch and embodied into the Tentacle Control System.

Motion Compensation

The primary objective of the Tentacle Winch is to increase the performance envelope of the launch, towing and recovery of a sensor platform such as the KATFISH system. It achieves this by reducing the coupling of unwanted surface vessel motions into the towed sensor platform, which is essential to maintain the stability and safety of the towed platform. Motion compensation systems designed for decoupling of vessel motions can be either passively or actively controlled. Although passive systems are typically simpler, they are limited in the frequency and magnitude of motion they can decouple and can cause resonance issues due to the inherent natural frequency of the passive damping system (such as in a spring-damper). Fortunately, with advances in control system technology, active systems are becoming much less complex and less expensive.

Most active systems compensate for heave motion. However, for small surface vessels such as USVs, surge motion can be a major factor, especially when the trail—the distance behind the towing vehicle—is high compared to the depth of the towed body. Because of this, we've designed the Kraken system to compensate for both heave and surge.

The three common types of motion compensation systems determine motion based on the cable sheave position on the vessel:

- A flying sheave system consists of a sheave mounted on a linear motion device such as a hydraulic cylinder. The cable is wrapped 180 degrees around this sheave, and the cylinder moves in and out, effectively changing the cable length to compensate for the vessel motion.
- A nodding boom system has a sheave, over which the cable passes, mounted on the end of a boom that is driven up and down to compensate for the vessel motion.
- A winch drive system takes the motion information and then pays out or reels in the cable to compensate for the calculated heave and surge motion.

The Tentacle ALARS employs a winch drive system due to the overall space efficiency, and unlimited magnitude response due to the large cable length.

Tentacle Control System

The Tentacle Control System within the ALARS is both the brain and the nervous system, sensing stimuli, processing feedback and generating actions automatically. It consists of two components which operate in tandem; the low-level

(subconscious) control system, and the high-level (conscious) operator control systems. The low-level control system is akin to the conditioned reflexes observed in nature and in humans, monitoring sensor stimuli and reacting almost instantly without conscious thought. Four key features of the low-level control system are its Active Motion Compensation, Active Terrain Following, Constant Tension and Auto Render. The Active Motion Compensation (AMC) module is the main feature which separates the Kraken Tentacle Winch. Using a series of proprietary motion tracking and motion prediction algorithms, the AMC system is continuously tracking the motion (speed, orientation, position) of the host vessel and the motion (speed, orientation, position) of the KATFISH, and calculating the necessary speed and torque it must apply to the winch and tow cable in order to compensate for the vessel motions. The AMC module operates autonomously, without human interaction or conscious thought, and effectively decouples the host vessel motion from the KATFISH, drastically increasing the operational envelope of the KATFISH system.

The Active Terrain Following (ATF) module allows the KATFISH to command the winch. In this case, the KATFISH detects that the seabed is rising or falling and issues a command to the ATF module to automatically adjust the cable scope to help the KATFISH actively follow the terrain. The speed of the cable payout or reel-in is monitored and adjusted, and in the case of emergency conditions such as bottom avoidance, the cable can be reeled-in with great speed.

The Constant Tension (CT) module, as its name suggests, is intended to maintain a constant specified tension on the tow cable. This is calculated based on feedback from the torque sensor in the motor and is very effective at eliminating sudden tension impulses on the tow cable due to waves or small surges. This module also allows the winch to hold the KATFISH in the docking head during launch and recovery without an additional capture mechanism.

The Auto Render (AR) module provides a fail-safe feature that allows the system to automatically pay out cable if the tow load exceeds a pre-set threshold. In the worst case that the tow body impacts the seafloor, or entangles itself on other marine gear, this cable payout can help to "free" the tow body and

Figure 3: **Sample Display.**

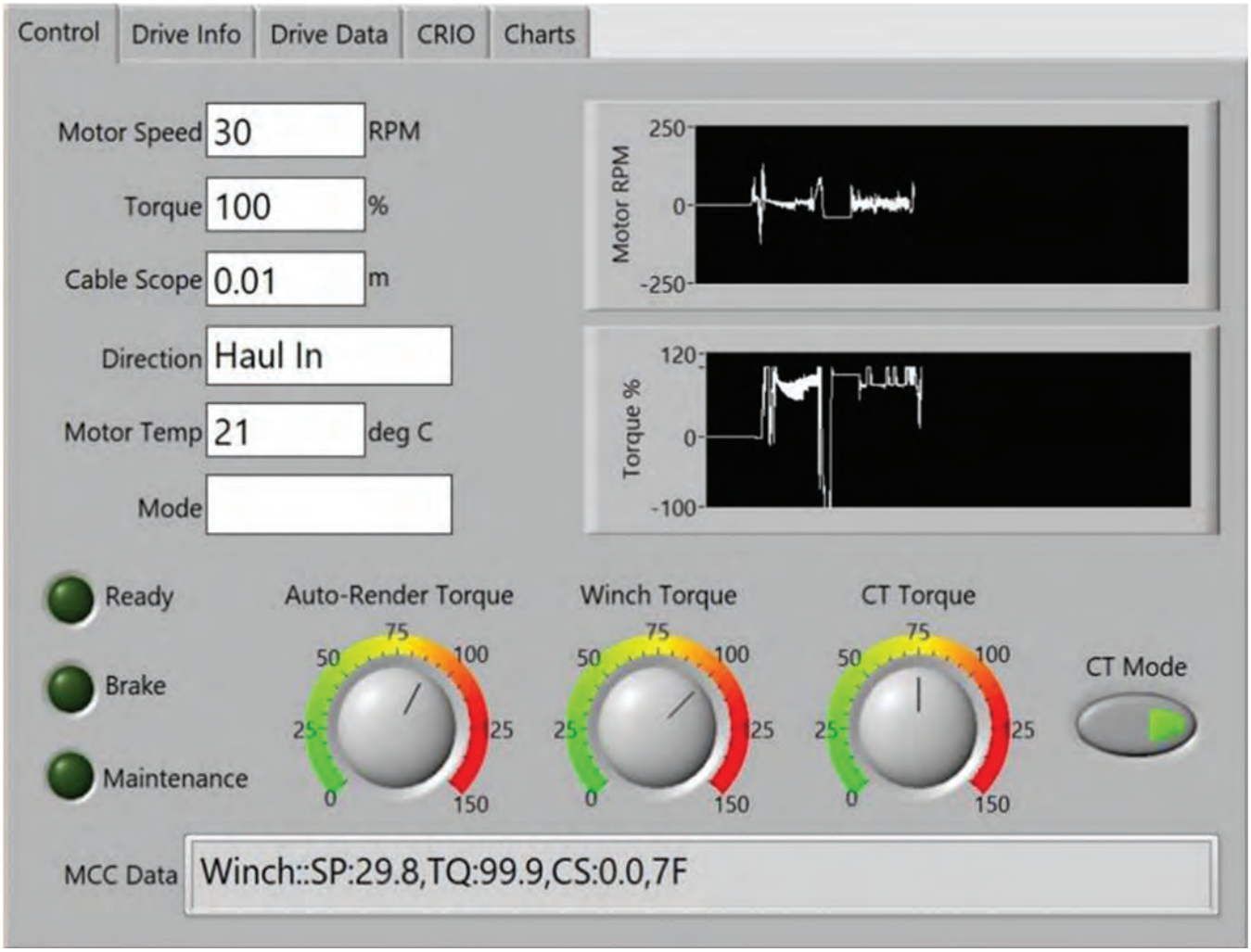


Photo: Kraken

minimize the risk of damage to the tow body while eliminating any risk of cable breakage.

The high-level control system is akin to the conscious actions of a human operator, and allows for control of launch, deployment and recovery to be fully manual, remote or autonomous. We designed the control system to be flexible, using Ethernet and Wi-Fi communications throughout so the entire system can be integrated easily with other shipboard systems. The high-level control system is made up of an operator control panel, electrical control panel, winch and actuator motors, and a variety of limit switches and sensors to limit range of motion and detect the correct launch and recovery of the KATFISH. The operator panel consists of a touch screen, manual controls and indicators. The touch screen (which can be used with gloves, in real-world weather conditions), provides the operator with current and historical operating data, configuration of operating parameters and alerts and warnings. The status of the autonomous controllers is continuously monitored, and real-time information is broadcast over the Ethernet and Wi-Fi interfaces. Operators can wirelessly monitor the operating status and view key data such as cable direction, scope and speed and critical parameters such as motor temperature and cable load.

Safety Features

Safety is priority number one in any marine operations, and Kraken has taken this to heart within the design of the Tentacle. Although many creatures can survive and regrow severed limbs, humans are not one of them. The Tentacle Winch includes a variety of autonomous controllers and intelligent modules, all of which prioritize the safety of the human operator and any other deck personnel the above all else.

We made sure that the safety features were clear and easy to use. Each control panel has an emergency stop (E-stop) switch; the operator panel has an additional E-stop that can be connected on a flying lead. When the E-stop is pressed, the system immediately stops motor operation and disconnects power to the motors. A variety of warnings on the operator panel also alert the user to parameters that exceed pre-set operating thresholds. A movable light stack with audible alert provides a visual and audible indication of the operating status.

Although not as fast as the neurons used in withdrawal reflexes in nature, the Tentacle Control System includes a real-time processor and field-programmable gate array (FPGA) for almost instantaneous and deterministic safety responses processed directly in hardware. This ensures all safety features and fail-safes react instantaneously, regardless of the operational state of the Tentacle

Future Development

We believe the Tentacle Autonomous Launch and Recovery System and Intelligent Winch technology is an excellent platform for further development. It is a versatile combination of key enabling technologies, and each of those technologies is fundamentally scalable for larger (or smaller) applications.

In an effort to mimic the memory of a typical human, the onboard memory of the Tentacle Winch records all motion data within the system and any significant motion events (over temperature, excess torque, excess tension, etc.) This data can be used to automatically tune the control system modules through machine learning techniques, improving the response times and overall performance, furthering conditioning the reflexes of the Tentacle.

One example future application under consideration is supply ships and other vessels that experience relative motion issues. These vessels would benefit greatly if the motion compensation system were augmented by motion data from a floating target platform. The system could then determine the relative motion between the host vehicle and the target platform and adjust the cable length so the target would see no relative motion between the cable end and the platform. As more sophisticated motion control technologies become available, they can be easily incorporated into the Tentacle system. Like its namesake in nature, the system is strong and flexible.

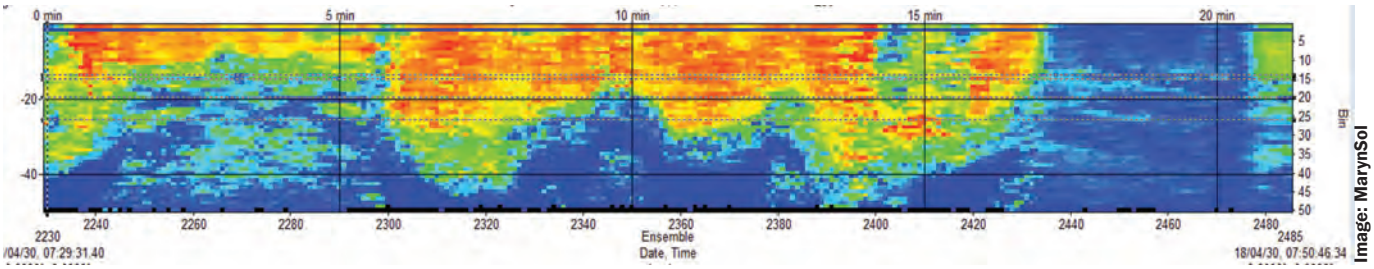
Robots for I

Photo: ROVCO

The Gwynt Y Mor wind farm.

Renewables

As the global fleet of offshore renewables fleet increases, ways to reduce the cost and increase the efficiency and safety of operations and maintenance work, using robotics and autonomous systems, will also grow. Elaine Maslin reports.



Islay Sound ADCP data. Image from MarynSol.

Robotics and autonomous systems are moving into many areas of modern day life. It's becoming harder to avoid them, from our phones to automotive systems and now offshore energy renewable projects.

Both are seen as tools to do otherwise dull, dirty or dangerous work, without human involvement, but also as a way to reduce operational cost and to produce more reliable repeatable data.

Marine renewables is seen as a space ripe for innovation in this area, especially around operations and maintenance (O&M), which is a largely human intensive activity, limited by access issues, above and beneath the waves.

HOME Offshore (Holistic Operation and Maintenance for Energy from Offshore Wind Farms), a consortium of universities working on remote and autonomous inspection technologies for subsea cable inspection, says 80- 90% of the cost of offshore O&M is generated by access requirements and that routine subsea inspections can be slow and costly and often include manual visual inspection with large margins of error.

Some inspection needs weren't anticipated, including grouted joint issues, which effect some 35-40% of installed monopile foundations (mostly pre-2012 installed structures), caused by the harsh marine environment, according to the Offshore Wind Accelerator (OWA), a Carbon Trust project supported by nine offshore wind developers. Many of the structures built after 2012 will also need performance monitoring while new designs such as jackets, which are constructed using welded nodes, will also present inspection challenges, says the OWA.

In addition, currently 70% of subsea power cable failure modes cannot be monitored in-situ, inhibiting accurate health monitoring, says the HOME Offshore group. "By integrating technologies, such as autonomous underwater vehicles and advanced sonar technology, we will gain a new insight into the condition of these subsea assets," says Dr David Flynn, director of the Smart Systems Group at Heriot-Watt University, and a member of the HOME Offshore group.

There's going to be a large market to address. Some 3.1 GW of new offshore wind capacity was installed in Europe in 2017, double the capacity installed in 2016, according to WindEurope, a trade body. By 2020, WindEurope expects a total European offshore wind capacity of 25GW – with all the associated infrastructure that comes with it.

HOME Offshore estimates that use of remote inspection and asset management of offshore wind farms and their connections to shore could be an industry worth up to £2 billion annually by 2025, just in the UK. The UK's Offshore Renewable Energy (ORE) Catapult thinks that 20-40% savings could be made by using remote operations.

Surface

Unmanned surface vessels (USVs) could be part of the solution, for parts or personnel transfer, but also survey and surveillance, Simon Cheeseman, Sector Lead, Wave & Tidal Energy, at Offshore Renewable Energy (ORE) Catapult, told the All Energy conference in Glasgow in early May. "USVs could be used to run small-scale spares. It (a USV) could operate in a wider weather window, no one gets hungry, and you can put other sensors on there, for cable monitoring and security, all on a single multi-purpose platform. It could enable other stuff we have not thought of so far."

According to ASV Global, an autonomous vessel provider, as much as 60% of offshore wind farm operating costs are related to vessels. A £900,000 Innovate UK supported, 18-month project, called the Windfarm Autonomous Ship Project (WASP), is looking at what is needed to use USVs in offshore wind farm maintenance. WASP is being led by ASV Global, in partnership with the ORE Catapult, with SeaRoc Group, Houlder and the University of Plymouth. The group will work with Ørsted (Previously Dong Energy) on use cases, relevant to the Hornsea One offshore wind farm, 140km off the coast of Yorkshire.

Some of the technical challenges for autonomous systems, both surface and subsea, include being able to navigate, obstacle avoidance, self-diagnostics and recovery and the integration of autonomous systems into manned maritime co-

A Remus AUV being deployed in the Corran Narrows.

Photo: MarynSol

ordinated systems, says Cheeseman. There are also concerns, around data security and hacking, which could cause damage to a transformer or sub-station, and also societal concerns, around autonomous systems.

However, USVs and AUVs are already being used in offshore renewables as part of survey operations. Edinburgh-based MarynSol has been using USVs to do rapid surveys of tidal systems, to aid in feasibility studies and array design for tidal energy sites. The firm's director, Dr Jonathan Evans, told All Energy that using a USV, such as ASV Global's C-Cat, or an autonomous underwater vehicles (AUV), like a Remus, with a sensor package and MarynSol's SeaSmart software, can mean rapid mobile observations and automated processing and reporting. "The use of robotic marine vehicles as the survey platform reduces the limitations caused by costs, risks and physical endurance of the crew," he says. "Automating the data processing reduces the costs and error risks of manually handling/processing of the data."

With a conventional approach, a static ADCP would be used on a vessel, requiring a crew, usually at a single location (or two or three if you are very lucky), for at least one lunar month, followed by a week (or more) of post-processing reporting with no direct observations across the whole array site and you can only validate an area simulation model at single location, says Dr Evans.

Using SeaSmart and a mobile ADCP on a marine robotic vehicle (AUV or USV) means being able to cover the whole potential array site. "It can target specific tides over a short period (3-4 days)," says Evans. "It has highly automated post-processing of data to provide large area model validation and rapid results - usually within a hour or less, which facilitates additional immediate follow-up measurements."

In late April, MarynSol used a C-Cat3 in the Sound of Islay North Channel. It ran repeated legs around the Sound, then the

A C-Cat 3 from ASV being used for ADCP work in the Sound of Islay.

data was stacked and could be sliced and a video produced. It showed a lot of internal structure in the data, says Evans, “water over flowing over each other bouncing off bathymetry, 3-4m/sec in some places, with interesting shear profiles.”

Visualization

A number of projects are focusing on subsea visualization technologies supported by subsea vehicles, to assess offshore renewables assets. An OWA project will see Kraken Robotics demonstrate its SeaVision 3D RGB Underwater Laser Imaging System on foundations. An initial system, incorporating a high-resolution camera and laser to create as built point cloud models, was designed for deployment on underwater robotic platforms such as ROVs and AUVs.

Another project, with ORE Catapult support, will see Bristol-based Rovco to use its 3D visualization technology with subsea robotic systems to image offshore wind foundations, supported by artificial intelligence-driven software, to lower inspection costs by 80%. A system was moving to full testing and validation at the ORE Catapult’s National Renewable Energy Center in Blyth, northeast England.

Photo: ASV

Grout

To address the issues around grout and weld faults on monopiles and jackets, the OWA is supporting a number of subsea technology developers, including Oceaneering. The US-based firm is one of two being supported to develop jacket foundation weld inspection technologies. Oceaneering has offered a tool which will attached to the jacket structure to perform a detailed scan of node welds. Kraken Robotics, meanwhile, developed laser imaging device, which can be deployed on an ROV, which could find locate defects before the more targeted Oceaneering tool is used.

As part of the same project, Uniper and Next Geosolutions are developing subsea monopile and grout inspection technologies. Working with British Geological Survey, Uniper has offered a tool to do low frequency ultrasound inspection at the wavelength of the grout thickness. Spectra reflections from the ultrasound can be interpreted to show gaps or disbandment in the grout.

Next Geosolutions, as part of a consortium with Hydrasun and Ashtead, is also developing a tool to perform subsea grout inspection using wideband sonar inspection, inspired by bottle nose dolphins. This will examine grout condition between jacket steel components. Offshore trials for all the OWA supported technologies are planned for this summer/Autumn 2018.

Subsea Cables

Monitoring subsea cables may be a harder task. While most offshore windfarms have been built in shallow waters, relatively close to shore, visibility is poor and there are often strong currents. Power cables are typically buried or covered by sand, mud or silt, making survey with traditional methods challenging. Sand banks in the southern North Sea can also shift dramatically, over night.

AUVs could be a key tool in this development. ORE Catapult says offshore wind farm operators who use AUVs can reduce their levelized cost of energy (LCOE) by 0.8%. Applying this cost saving for a 400MW representative offshore wind farm, a 0.8% LCOE reduction will yield cost savings of £1.6 million a year, the organization says. Across the current 11GW of European installed capacity over this next 25 years, that could equate to as much as £1.1 billion.

One of the projects in this space is Darlington-based Modus Seabed Intervention's resident AUV docking station project (see MTR: May 2018), which is being supported by the ORE Catapult. This is aimed at having vehicles remain in field to survey and inspect offshore wind farm subsea infrastructure, instead of having to be supported by support vessels.

New Frontiers

The inspection opportunities will further open-up as new frontiers open up in the offshore renewables space, not least within floating offshore wind. While there is only one operating pilot offshore wind park today, Statoil's Hywind park offshore Peterhead, Scotland, with five floating wind turbines, the global potential is seen as significant. With more subsea components than fixed bottom wind turbines, including hulls, mooring lines, anchors, and cabling, there's potentially more work to be done here.

Indeed, Oceaneering International Services was recently selected as a contributor to the Carbon Trust-led Floating Wind Joint Industry Partnership (JIP) study so assess monitoring and inspection requirements for floating wind projects.

Offshore renewables is an emerging market in the O&M space. As more facilities are built, the case for using robotic and autonomous systems as part of their operations and maintenance will grow.

HOME Offshore estimates that use of remote inspection and asset management of offshore wind farms and their connections to shore could be an industry worth up to £2 billion annually by 2025, just in the UK.
The UK's Offshore Renewable Energy (ORE) Catapult thinks that 20-40% savings could be made by using remote operations.

Rovco launches an ROV on a windfarm survey.

Photo: ROVCO

Photo: Hydroid

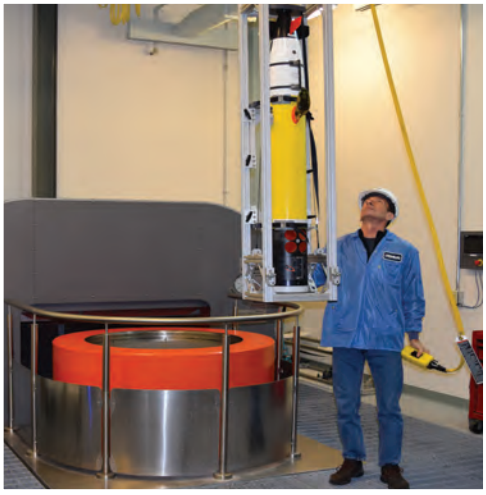
Duane Fotheringham

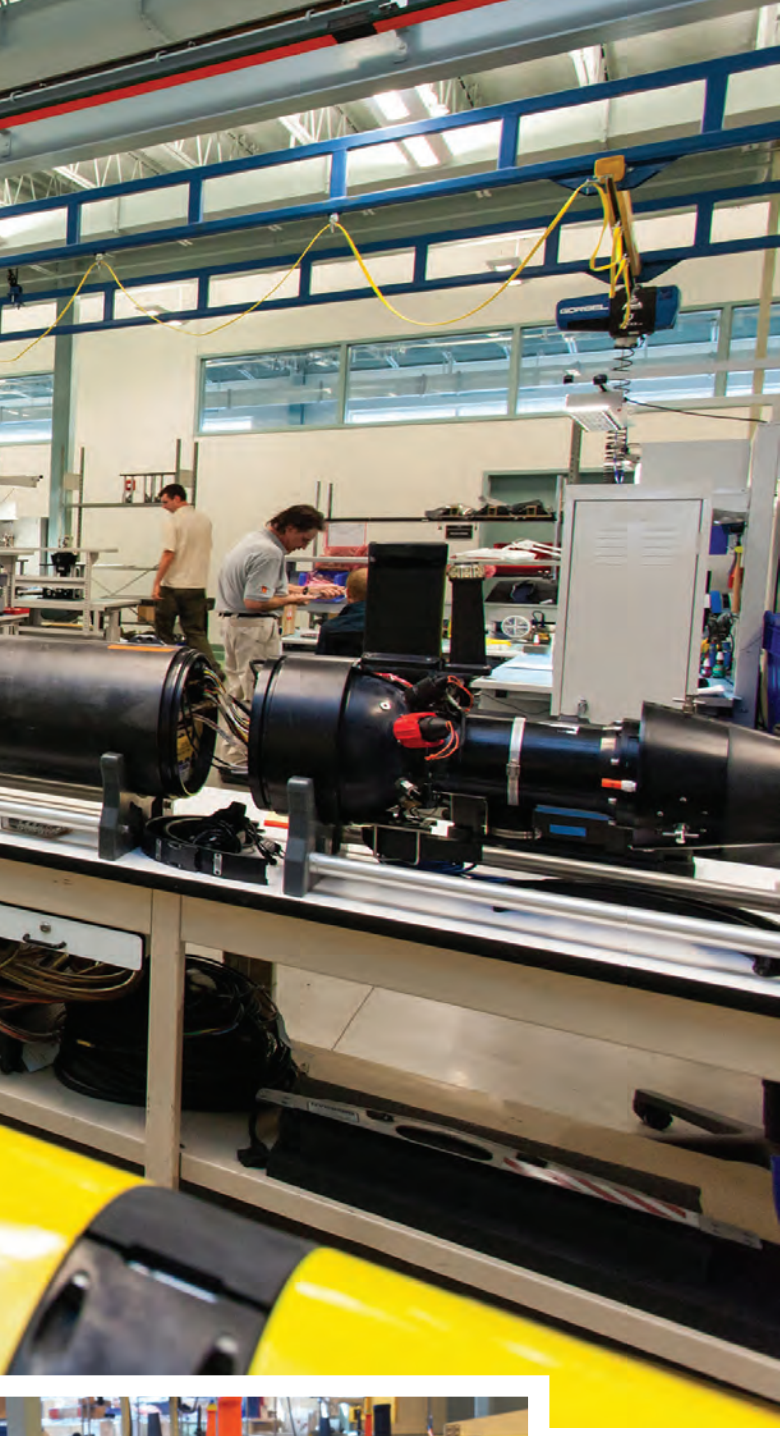
President & Chairman of the Board, Hydroid

For the "Defense" edition of *Marine Technology Reporter* we visit with Duane Fotheringham, president and chairman of the board of Hydroid, a Kongsberg-company seated in Pocasset, MA, a ubiquitous name in subsea defense circles with nearly 70% of its business coming from the sector, and one of the longest-tenured AUV makers in the world.

BY GREG TRAUTHWEIN

Photo: Hydroid





The Hydroid Workshop at headquarters is humming with activity.

Courtesy of his nine-years as a U.S. navy officer driving fast-attack submarines, it can be said that Duane Fotheringham knows a thing or two about subsea defense. Fotheringham is president and chairman of the board of Hydroid, a Kongsberg company, one of the true pioneers in the development and delivery of efficient, effective autonomous underwater vehicles, founded in 2001 by the inventors of the REMUS AUV.

But Hydroid does not rest on its laurels, particularly in a day and age where technology development moves at light speed, driven by upstart 'disruptors' which are driven to break traditional industry sector molds in delivering cheaper, more efficient solutions. In fact, while Hydroid is not even 20-years-old yet, it is a pioneer in the AUV field and one of the mature players. Yet it maintains its innovative roots, and in fact has made "a significant investment in a small, start-up 'skunkworks' company that does autonomy work for automotive and other industries," said Fotheringham. "We're trying to leverage some of that work that's going into other industries, and bring it back into our area."

Fotheringham at the Helm

Upon leaving the navy Fotheringham joined Kongsberg Underwater Technology in its Lynwood, Washington office, now a 20-year-veteran of the global maritime and subsea giant.

"In 2008, Kongsberg acquired Hydroid, so I had the opportunity to move out to Cape Cod and become part of Hydroid as Vice President of Operations, responsible for manufacturing and engineering," said Fotheringham. When Chris von Alt, the ubiquitous founder of Hydroid, retired in 2013, Fotheringham took over at the beginning of 2014 as president, adding the chairman of the board title in 2016.

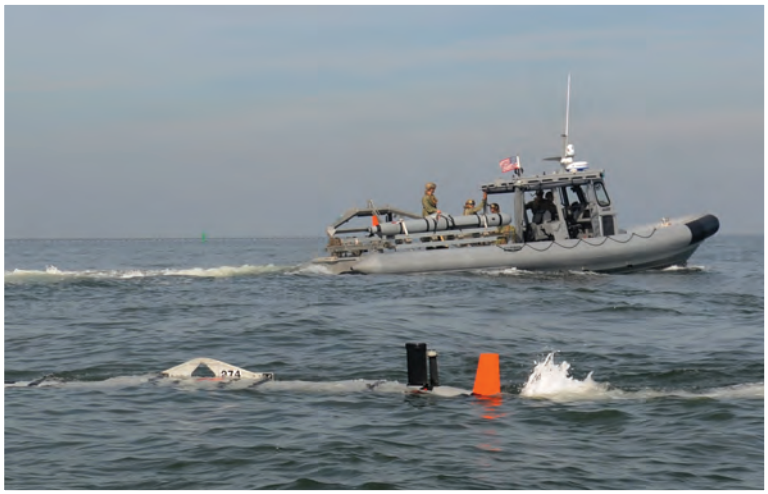
Though Hydroid is owned by a much larger entity in Kongsberg, one of the characteristics that Fotheringham said is the same since he joined is its penchant for being a small, entrepreneurial company with a strong customer focus.

"Hydroid (was born) caring about the technology and finding solutions to apply that technology. That is the history of Hydroid, it's about solving our customers problems, not about selling them a product or selling them a vehicle," said Fotheringham.

Technology acquisitions are the norm, not the exception, and in the case of Kongsberg and Hydroid, Fotheringham recognized the synergies before he switched coasts in 2008.

"It's an extremely good match because the Hydroid and Kongsberg cultures are very similar: a drive to build new things and solve problems with technology," said Fotheringham. "All of the Kongsberg companies operate in extreme environments: from deep sea to outer space and missile systems. There's this whole culture of operating in harsh environments that are very unforgiving."

In particular, Hydroid has access to the breadth of Kongsberg technologies. "Kongsberg makes some world-class sensors,




1204
282

"Last summer we did an exercise, the Advanced Naval Technology Exercise, or ANTX, for the U.S. Navy and we demonstrated the launch of an unmanned aerial vehicle from a submerged AUV. So there's a cross-domain solution where you can deliver a platform covertly through an AUV launching a UAV," said Fotheringham.

Photo: Hydroid

for example hydrographic sonars and synthetic aperture sonars, and those are extremely well suited to putting on AUVs," said Fotheringham. Add to that the high precision Kongsberg navigation solutions, and the combination is difficult to match.

In the Navy

Investment in navies globally is booming, no more so than in the United States where the new Administration signaled early its intent to fortify a seagoing fighting and defense force. As with other areas of the military, autonomy is emerging as a preferred tech solution for navies, both in terms of keeping humans out of harm's way and also as a force multiplier.

"There is a very clear push – in the military, and more specifically in the U.S. Navy – for the adoption of unmanned systems," said Fotheringham. "It is about doing more with less. Using unmanned systems to do jobs that were not previously able to be done with manned platforms, or removing people from dangerous situations. Mine countermeasures is a great example."

AUVs are a force multiplier. "We have seen it in many areas where the user can launch multiple unmanned systems off of a single manned platform," said Fotheringham. "They can go off independently – operate in complete autonomy – perform a mission and come back."

But the battlefield is far from one-dimensional, and Fotheringham said that Hydroid systems must be outfitted and capable of operating seamlessly cross-domain, with assets on the water, in the air and on the land.

"Last summer we did an exercise, the Advanced Naval Technology Exercise, or ANTX, for the U.S. Navy and we demonstrated the launch of an unmanned aerial vehicle from a submerged AUV. So there's a cross-domain solution where you can deliver a platform covertly through an AUV launching a UAV," said Fotheringham.

An Industry Grow; Needs Evolve

"If you look at the competitive landscape – and I think this is true of any industry as it matures – there will be more and more competitors. The market size for AUVs has increased significantly," said Fotheringham. "We see big companies investing, we see smaller AUV makers consolidating, we see a lot of new start-ups coming in. But I think competition is good. If the market wasn't growing and the opportunities weren't there, people wouldn't be entering the market. Competition makes everybody a little sharper and drives technology."

Building a more robust, durable and efficient vehicle is one thing, but "Open Architecture" opens your solution to outside suppliers, leveraging best available technologies no matter where they emanate, is the key to future success. Think iPhone, think Apps.

"Our customers are asking for open architecture systems, so all of our new generation of vehicles (and really, existing vehicles did to a point) have an open architecture platform," said

Photo: Hydroid

"There is a very clear push – in the military, and more specifically in the U.S. Navy – for the adoption of unmanned systems. **It is about doing more with less.** Using unmanned systems to do jobs that were not previously able to be done with manned platforms, or removing people from dangerous situations. Mine countermeasures is a great example."

Duane Fotheringham, Hydroid

Subsea Navy: Tech Drivers

Doing business with the world's navies means working with cutting edge technologies. It also means confidentiality. So when we asked Duane Fotheringham, president and chairman of the board of Hydroid for his insights on the major technology drivers in navy operations today, he offered:

- **Power**

Right now, lithium-ion batteries are the most common solution, arguably the best, most mature solution. They are a good, reliable, technically mature solution with a reasonable power density, a power density which continues to make incremental improvements. But there is a limit of how good batteries will get. So we're looking into fuel cells, and really anything that's capable of making the vehicle stay out longer.

- **Communication**

There are some basic, physics limitations with underwater communications. You can't break the basic laws of physics, but we're working on ways to improve what we can do down there. We're also looking at ways to integrate high bandwidth radios that, even with the vehicle then on the surface, we can get larger amounts of data.

- **Information Processing**

One way to circumvent communication limitations is to move more processing onto the vehicle. With our Synthetic Aperture Sonar we're doing all of the processing in-mission so when we have to move data off the vehicle it is a smaller amount.. We can also use auto target recognition software to find the pieces of information in the data that we really need, and move just those pieces of data off the vehicle.

- **Autonomy & Decision Making**

As AUV power gets better, the missions get longer and more information is collected. Now talk turns to the vehicle making better decisions, they have to be able to navigate themselves, vehicle autonomy has to continue to get better.

Fotheringham. “The vast majority of them come with ROS – or Robotic Operating System –so there are a lot of things that already exist in the whole infrastructure. It allows third parties – whether it’s our customers or other vendors – to develop (software or hardware) applications for our vehicles. We want to build a very solid, reliable platform that performs its core mission, and we also integrate a lot of sensors, but we also recognize we’re not the only people with good ideas.”

“Take the iPhone. It is a solid, reliable piece of hardware that performs many core functions; it makes phone calls, it has GPS and it has Wi-Fi,” said Fotheringham. “But the thing that makes it a really useful product is all of the apps that you can put on it that leverage all of those sensors and all of that data that’s on the phone, to solve a problem that you have … uniquely. If you took your phone out and my phone, we’d probably have a completely different set of apps because there’s different things that we do, and different ways we use our phone, and different ways we want to see our information. That’s one of the powers there of creating an open architecture system is that it can be easily customizable and upgradable in the future, it allows the users to have more flexibility and feel like they can go and do other things with the vehicle that they don’t have to just come to Hydroid.”

Investing in the Future

Investment in the high-tech sector is continual and not for the weak of heart or light of wallet. “Over the last several years you have started to see the fruits of our investment, our new generation technology,” said Fotheringham. “The first product that came out of the new generation was the REMUS 100, which is our most popular and most widely sold vehicle. From the outside it looks like a very similar vehicle, but inside it is completely new architecture. It’s based on a state-of-the-art ‘core electronics.’”

According to Fotheringham, the key to the new tech is not simply the latest electronics, rather a core system that is configurable and adaptable to future needs. “The main brain of the vehicle is an FPGA-based processor to allow maximum future flexibility. Electronics obsolescence is always an issue, so it’s brand new now long-life, hopefully 10+ years out of that platform. But it’s also configurable for the future; it’s small, it’s low power, it’s powerful and it’s configurable.”

Today Hydroid is driving the new generation technology throughout its armada of vehicles, even driving the development of a new, lower-cost model. “We are producing the new generation REMUS 6000 which is our deep-water vehicle. In the next 12 to 18 months, you’ll see a new generation REMUS 600 that’s built on that same architecture – that architecture also contains this full ROS-based infrastructure for open architecture.”

At Oceanology International in London Hydroid debuted a completely new vehicle platform in the A-sized vehicle, 4.875 in. diameter x 36 in. long and 10 kilos, conforming to NATO A-sized sonobuoy package. “That’s our entrance into the lower cost vehicle that’s below the REMUS 100 and brings capabilities that don’t exist in those other vehicles: high speed – 10-plus knots – able to operate in multiple modes with either a traditional AUV surveying mode or in a buoy mode with the tail and the antennae up and the acoustics still in the water,” said Fotheringham. “It’s at a much lower price point and capable of being air-dropped, so it goes into other markets and solves other problems. But inside it’s the same core that’s running inside the vehicles. It’s the same open architecture. It’s the same software.”

Outside of the electronics, Fotheringham said the company invests regularly in all aspects of the AUV, including new propulsion for the vehicles. “It’s a prototype now, but we expect in the next six months or so to show a new high-speed propulsion system, because a lot of our users want the ability to either go faster or work in higher current environments,” he said.

Summing up Hydroid, Fotheringham is succinct: “When you buy a REMUS vehicle, you’re buying everything that comes with more than 450 vehicles built and in the field, you’re buying 17 years of experience building AUVs and all of those lessons learned, all of that software that’s been developed, from the low cost A-sized vehicle to the REMUS 6000.”

Taking UUVs
Faster, Further & Deeper

By Justin Manley, Just Innovation &
Jeff Smith, Riptide Autonomous Solutions

Micro-UUV Technology is Flexible

In 2015, veterans of the conventional UUV sector set out to change the dynamics of the industry, founding Riptide Autonomous Solutions. Riptide's first product was the micro-UUV, a new, highly flexible, open source autonomous undersea vehicle that provides a state-of-the-art, low cost solution ideally suited for developers of autonomy and behaviors, power systems, subsea sensors, and other new payloads. The micro-UUV features open hardware and software interfaces giving users a reliable and robust platform to advance technology development. The vehicle design is optimized for high efficiency with the best hydrodynamic signature in its class. The base micro-UUV is 4 7/8 inches in diameter, 42 inches in length and weighs 23 lbs. The standard system is rated to a depth of 300 meters.

The Riptide micro-UUV launched a line of following vehicles including the 7.5 inch diameter, 65 pound, 1 man-portable (1 MP) UUV and the 9.375 inch diameter, 120 pound, 2 man-portable (2 MP) UUV. The underlying technology enabling this family approach, including advanced manufacturing and engineering techniques are key to the Riptide mission of taking UUVs Faster, Further and Deeper.

Deeper: Advanced Manufacturing

The micro-UUV was developed using multiple additive manufacturing techniques. This enabled affordable and quick evaluation of numerous design considerations. This rapid manufacturing capability also enabled Riptide to quickly field

Figure 1: The Riptide Family of Compact UUVs

Photo: Riptide

production vehicles. This approach is not just for engineering models. It is delivering product capable of withstanding the pressures and harsh environment of UUV operations. The use of modern design and manufacturing techniques has also enabled the development and delivery of numerous micro-UUV configurations of Riptide's flexible architecture as shown in Figure 2.

When Riptide started the design and development effort of their first micro-UUV in mid-2015, it traded hull materials for design flexibility, ease of fabrication, cost, and material properties such as strength to weight ratio. It set a design threshold for the micro-UUV of 200 meters (2-3X the depth rating of the nearest small vehicle competition at the time). It selected carbon fiber for the cylindrical vehicle mid-body, fabricated from a sailboat mast mold so highly flexible in length. For the hydrodynamic noses and tails, Riptide selected 3D printed nylon, providing extensive flexibility for shape and adding ports or mounting features for new sensors. Finite Element Modeling (FEM) was performed with desired factors of safety and additional conservatism built in for material and fabrication variations. Through validation and failure testing (shown in Figure 3, on page 44), the initial design was determined to well exceed the threshold depth rating, which was then increased to 300 meters for the standard vehicle while maintaining an adequate factor of safety.

Riptide utilized the latest methods of rapid manufacturing heavily relying on 3D printing or additive manufacturing in its early production deliveries. Riptide has recently procured injection resin molds for all 3D printed parts for the micro-UUV under a manufacturing grant from Massachusetts, but maintain the ability to 3D print any component for design flexibility. Under a DARPA Phase II SBIR, Riptide fabricated a deeper rated UUV (7.5" Diameter) with a design objective of 1500m. Initial seal testing and pressure testing of the hull sections was successfully completed and the first of several vehicles is undergoing first article testing. Figure 4 shows standard tail section versus the 1st article titanium 3D printed tail section. Volume was reduced for cost purposes. With the combination of 3-D printing and traditional molds, as well as novel designs, Riptide is delivering on its promise to take compact UUVs deeper.

Further: Power and Energy Management

The micro-UUV was designed for low logistics. The standard configuration uses 144 alkaline AA batteries just like a television remote control but in greater quantity. They can be swapped out in minutes. The use of alkaline batteries avoids many of the limitations and restrictions with shipping, safety, and government certification of lithium batteries, while providing enough energy to run these efficient vehicles for a day or more, depending on operational speed and payload power. In addition to flexibility in shipping, deployment is dramatically simplified with a vehicle of such small size. There is no need to rely on large, expensive surface vessels. Operations from the dock, from dinghies, and even from paddleboards are possible.

In total, 144 alkaline AA batteries provided the original micro-UUV approximately 300 Wh which, with no payload, running at peak efficiency gives the micro-UUV a range of a little more than 100 nautical miles in 33 hours. This presumed an operating speed of 3.0 knots. At 0.5 knots the same vehicle configuration could run for three days.

In early 2018, Riptide announced a near-total redesign of internal electronics resulting in a new MKII µUUV. This offered a nearly 60% reduction in hotel load power to 3.8 Watts

Figure 2. Selection of Vehicle Configurations

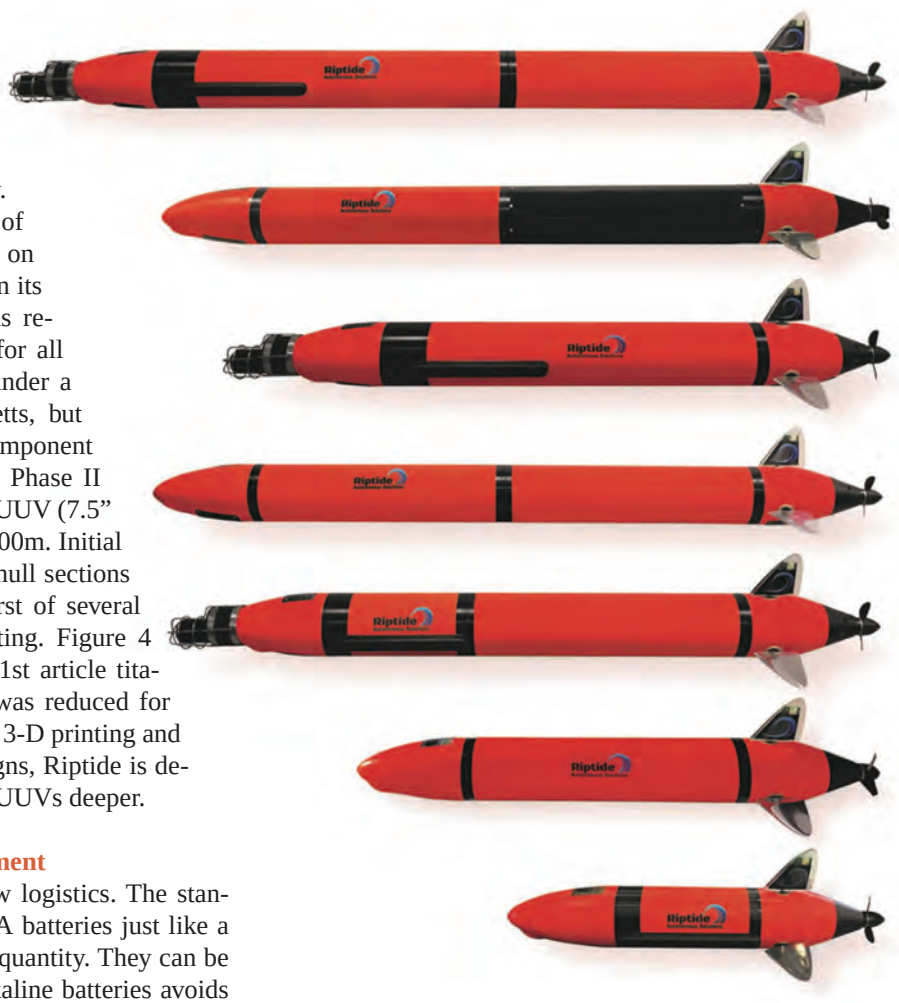


Photo: Riptide

Figure 3. Results of Failure Testing of the Micro-UUV Hull.

Photo: Riptide

Figure 4. 3D Printed Nylon (300 m) and New 3D Printed Titanium (1500 m) 7.5" Tail Section.

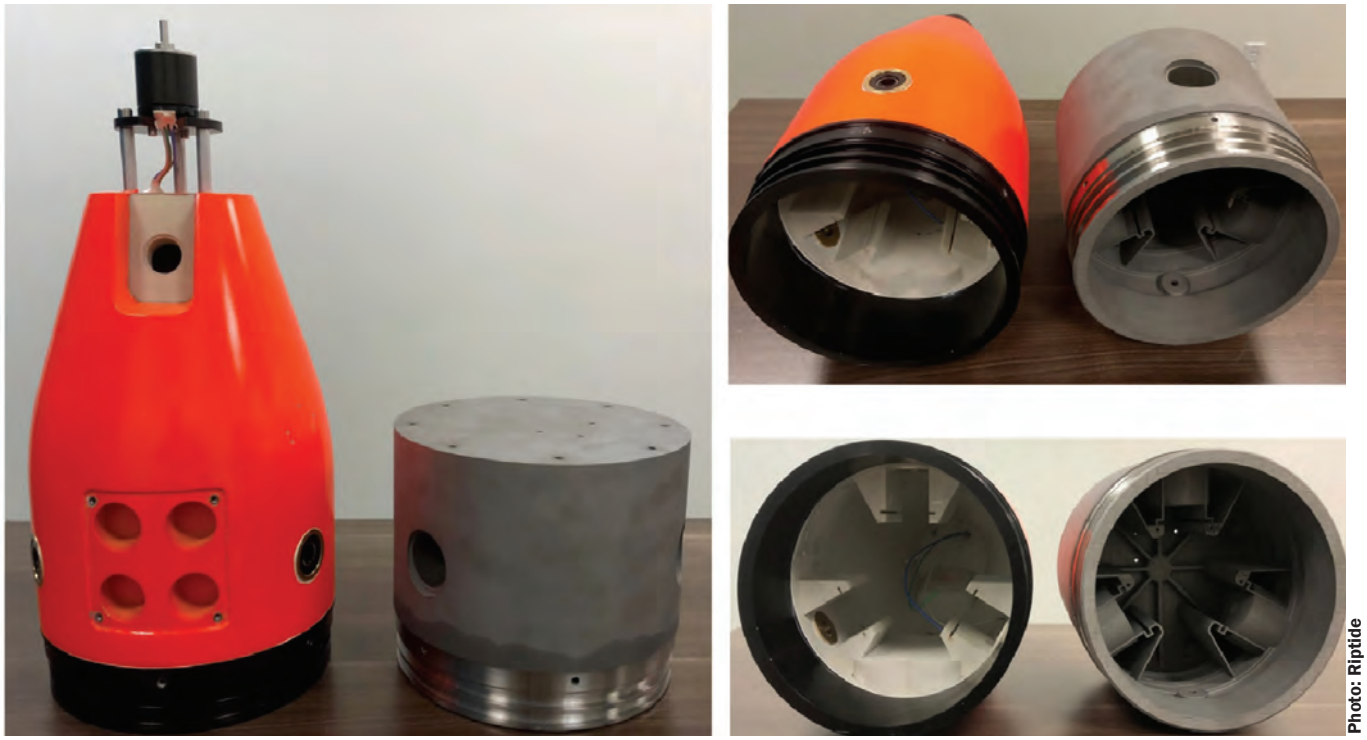


Photo: Riptide

Figure 5: A Typical Alkaline Battery Pack for a Micro-UUV

Photo: Riptide

from its first-generation boards. It also reduced the internal wire count in the vehicle by 80%, simplifying the vehicle further. This traditional battery based performance is more than adequate for many applications. But it can be improved upon. Riptide is releasing its lithium rechargeable battery pack that doubles the energy capacity (and endurance) of the standard vehicle. Additionally, its standard alkaline battery stack was designed to accommodate multiple battery chemistries, including lithium primary and nickel-metal-hydride cells. With lithium primary cells, the standard micro-UUV can operate for over a week at speed.

Through an exclusive partnership with L-3-Open Water Power the micro-UUV will pioneer the use of aluminum seawater batteries. This new technology harnesses the energy of a chemical reaction between seawater and specially developed, high-purity aluminum alloys. The result is an inherently safe energy storage solution with a dramatic increase in energy density. This technology will be tested in 2018 and is anticipated to be available commercially on Riptide UUVs in 2019.

Through both electronics optimization and new energy technologies Riptide is taking compact UUVs further than ever before.

Faster: Speedier delivery of user focused UUVs

Faster UUVs can suggest high-speed vehicles. While this is true, the micro-UUV can exceed 10 knots, an even more important measure is delivery time. The open-architecture and modular design of Riptide UUVs ensures that customer focused units can be rapidly configured and delivered. The original micro-UUV delivered on this promise with dozens of

Through an exclusive partnership with L-3-Open Water Power the micro-UUV will pioneer the use of aluminum seawater batteries. **This new technology harnesses the energy of a chemical reaction between seawater and specially developed, high-purity aluminum alloys.** The result is an inherently safe energy storage solution with a dramatic increase in energy density.

configurations built in the first year of production.

Since then, as the product lines have expanded the flexibility and fast delivery has enabled other distinctive configurations.

One example of a faster, and deeper UUV is the deep vehicle developed for DARPA.

Case Study: Deep Acoustics UUV

Under a SBIR program Riptide has modified their 1 MP UUV to support acoustic telemetry research programs.

The deep UUV is rated for 1,500 meters depth but still only 7.5 inches in diameter. Its payloads include CTD, acoustic modem and a towed acoustic receiver array. With industry leading low power hotel load this system can deliver over 48 hours of endurance for field testing. The purpose of the vehicle is to demonstrate long range, medium data rate acoustic underwater communications for a mission critical project. To accomplish this the client needed to operate for long periods in the deep sound channel. These waters, around 1000 meters deep, are typically out of reach of smaller, more affordable UUVs. Riptide's open source software and flexible mechanical design enabled the rapid development of this custom UUV and ensured the research program could be executed as planned. Figure 6 shows this vehicle as delivered.

Case Study: Open Architecture

In addition to hardware versatility the Riptide approach enables software flexibility as well. Working with Draper, Riptide has agreed to implement Maritime Open Architecture Autonomy (MOAA) on all Riptide UUVs delivered to the US Government. Draper developed MOAA for the US Government. MOAA capabilities have been demonstrated at-sea on several autonomous undersea vehicle (AUV) classes with application to various undersea mission areas. This work represents a significant investment, millions of dollars and decades of research and development.

Draper requested and received approval from the Naval Undersea Warfare Center (NUWC) to provide MOAA as an option on all Riptide UUVs sold to the US Government or Government purposed vehicles. This will be a no cost option on all Riptide UUVs for eligible customers. The availability of MOAA on Riptide UUVs is a direct result of their flexible and open software architecture. MOAA adds significant value for Government UUV customers and Riptide UUVs with MOAA will be available for delivery in the second quarter of 2018.

Faster Further Deeper

The unmanned undersea vehicle market is undergoing a period of rapid evolution. Legacy providers have been acquired by large defense primes, to support increasing programs of record. Meanwhile barriers to entry have been lowered through new manufacturing techniques, state-of-the-art electronics and open source software architectures. Riptide has leveraged all of these trends to deliver a flexible family of solutions. The technology approach has ensured faster delivery of UUVs that can range further, while diving deeper, than ever before possible in compact vehicles. With nearly 100 Riptide vehicles delivered to date, the market has clearly indicated it is moving faster as well.

Figure 6: A Deep Rated, customized, compact UUV

Photo: Riptide

These vehicles have two things in common:

Water and us.

Greensea's open operating platform is a proven technology, already in use in more than 800 manned, unmanned, surface, and subsea marine vehicles. Our platform integrates inertial navigation and supervised autonomy, allowing critical data to be shared throughout the system. Station keeping, dynamic positioning, target tracking, and target reacquisition are at your fingertips. All our systems are supported by Workspace, our intuitive, one-screen interface. With Greensea on board, you can stay squarely in control of your vehicle and your mission.

For more information, download our brochure at Greensea.com/brochure or call 802.434.6080.

GREENSEA


MTR
100

MARINE TECHNOLOGY REPORTER

APPLY TODAY!
SUBSEA AWARDS

The 2018 MTR 100 awards edition is the most awaited annual ranking of leading companies serving the global subsea industry. *Marine Technology Reporter*'s editorial team gathers candidates and stories from around the globe, covering the entirety of the global subsea sector, including:

- Operators
- Vehicles -- ROV, AUV, UUV & Hybrids
- Oceanographic Instrumentation
- Cables & Connectors
- Lights, Camera, Sonar
- Deck Machinery
- Offshore Geophysical
- Hydrographic Survey
- Research Institutions
- LARS
- Buoyancy
- & much more.

Apply today and your listing may appear in the July/August edition of *Marine Technology Reporter* – and in front of the world's largest and audited subsea circulation.

BPA AUDITED CIRCULATION **25,470**

APPLY TODAY:
http://mtr100.marinetechnologynews.com/

Deadline for Entries: July 5, 2018

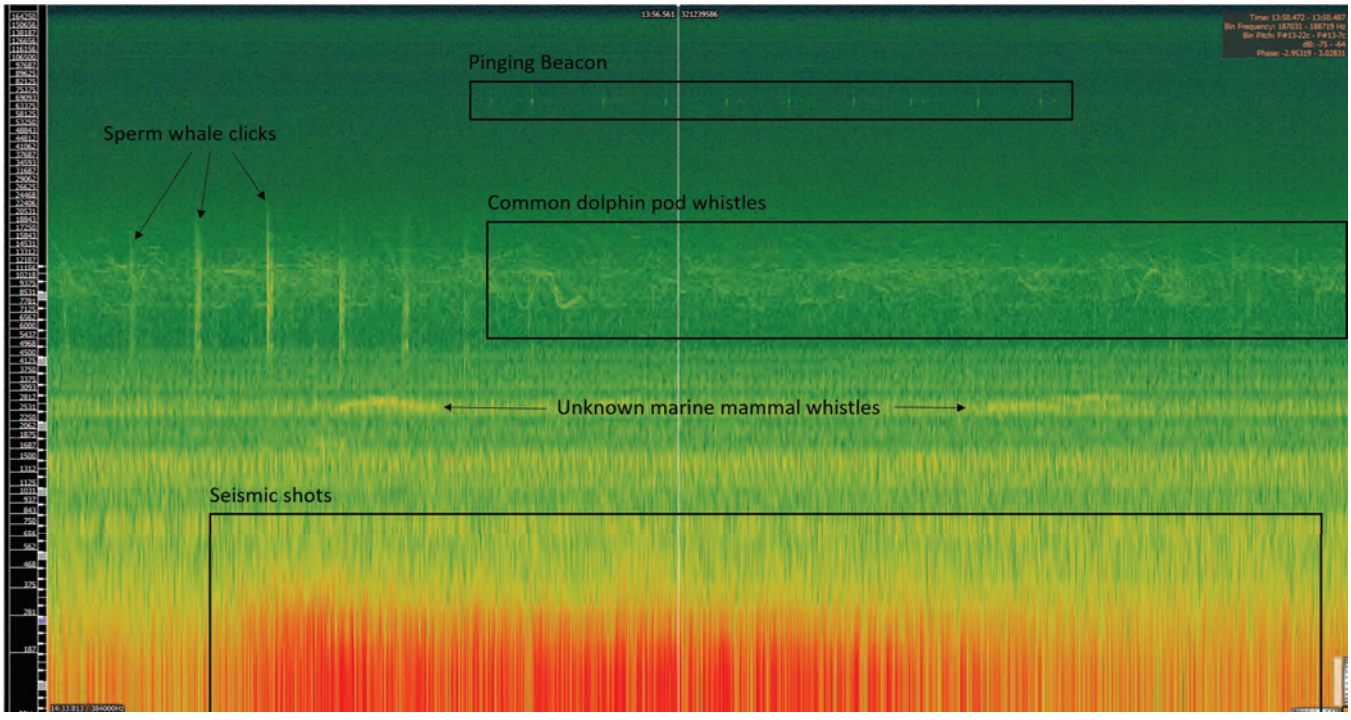
RS Aqua: RS-Orca & RS-Porpoise

RS Aqua has more than 30 years of experience in physical oceanographic monitoring. Two years ago the company expanded its base with the introduction of the RS-Orca suite of underwater acoustic recorders. Developed in collaboration with Canadian engineers Turbulent Research, the RS-Orca supports multiple hydrophone inputs, has extremely high sample rates and the onboard processing of acoustic data. These attributes allow the RS-Orca to capture some of the richest underwater data sets, and its ability to analyze data to standards required by the EU Marine Strategy Framework Directive removes the need for post-processing. While the RS-Orca has a large memory capacity with both SD and SSD formats, it can also stream raw audio and processed noise over Ethernet or long range Wi-Fi. This capability is increasingly required for in-situ mitigation against excessive noise in many types of offshore industry.

The RS-Orca comes in different form factors, and on a recent test deployment commissioned by the UK Government one was deployed on an autonomous Slocum glider diving repeatedly to depths of 600 m over five days. Sperm whales were encountered, as highlighted in the 50 second spectrogram clip shown.

With the multi-channel RS-Orca now well established, RS Aqua has introduced its smaller, lower cost younger brother, the single channel Porpoise recorder. The Porpoise has the same data processing capabilities as the RS-Orca but comes

The RS-Orca comes in different form factors, and on a recent test deployment commissioned by the UK Government one was deployed on an autonomous Slocum glider diving repeatedly to depths of 600 m over five days.



Photos: RS Aqua

in a compact 233 mm long pressure housing with a single integrated hydrophone. It provides additional measurement options, such as 24 bit recording, a switchable high pass filter, an accelerometer, compass, and temperature and pressure sensors. The Porpoise runs on AAA batteries which can be easily swapped out in the field, or can use various sized external battery packs for extended deployments. Initial tests suggest the Porpoise is more power efficient than other acoustic recorders on the market.

The Porpoise's 2 TB of SD storage provides ample memory, and like the RS-Orca it can stream raw or processed data over Ethernet and long range WiFi. The Porpoise is also capable of streaming audio in real time at higher bandwidths than other recorders, making it suited for the real time monitoring of marine mammals, including those which use high frequency vocalisations, such as the harbor porpoise. According to RS Aqua, these unique capabilities have led to a quick uptake of the Porpoise, with several multiple unit orders now confirmed for various deployments in the northern and southern hemispheres.

www.rsaqua.co.uk

Maldives Submarine Excursions

Relax by the pool, sip a cocktail on the beach, explore the marine environment in a submarine . . .

Guests at the Four Seasons Resort Maldives at Landaa Giraavaru are able to go beyond the typical vacation experience with an underwater flight excursion aboard the three-person DeepFlight Super Falcon 3S, a submarine designed specifically for underwater tourism.

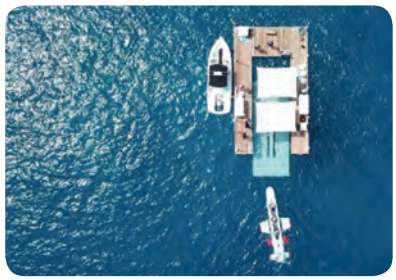
For $1,500.00 (+12% GST) per flight, a trained submarine pilot will take up to two guests below the surface to explore the beautiful Maldivian waters in DeepFlight Adventures' newest 8-meter sub.

Over the course of an hourlong dive, passengers can expect to skim over coral formations; fly through shoals of the 1,000 species of brightly colored fish that inhabit the BAA Atoll; and maybe even encounter creatures like turtles, sharks, dolphins and rays.

The battery-operated Super Falcon 3S features a brushless DC drivetrain and underwater lithium-iron-phosphate battery pack. It can dive to depths of 37 meters and features minimized electric and acoustic emissions so as not to disturb the marine life. Its flight-inspired design allows the Super Falcon 3S to glide effortlessly over reefs and cruise alongside marine life. It'll never land on the seabed or reefs.

While underway, a surface team constantly tracks and monitors the sub. In the unlikely event of power loss, fixed positive buoyancy combines with a thrust and lift system to enable the Super Flacon 3S to automatically float back to the surface.

DeepFlight Adventures said it is expanding to additional locations around the world through a cooperation with HadalX, based in Shanghai.



General Specifications

Occupants:	1 pilot, 2 passengers
Max. Operating Depth:	100m (330ft)
Dimensions LxWxH:	8m x 3.3m x 1.4m
Weight:	3400 kg (7500 lbs)
Max. Payload:	375 kg (825 lbs)
Max. Cruising Speed:	4 knots
Endurance:	up to 8 hours
Type:	Hydrobatic
Certifcation:	Lloyd's Register

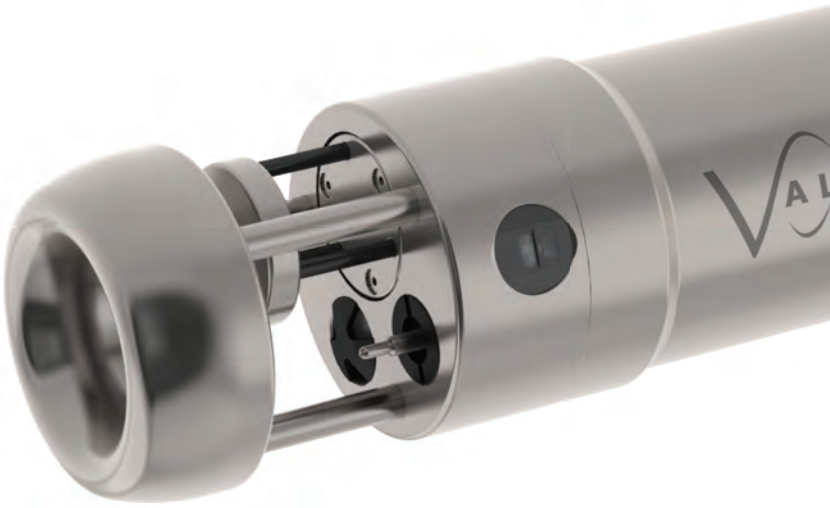
Photos: DeepFlight Adventures

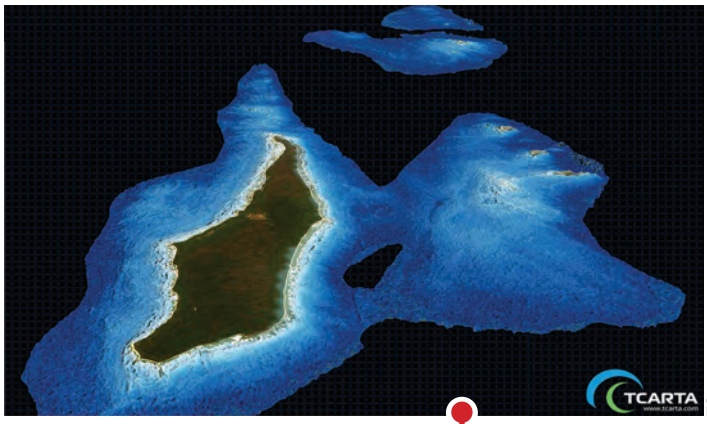
THE NEW SITE FOR NEWS

MarineTechnologyNews.com

The NEW online home of: MARINE TECHNOLOGY REPORTER

Photos:ConBit





TCarta

Unique Grillage Design for Offshore Wind Farm

Conbit has developed a unique grillage design as part of a collaborative scope for an offshore wind farm project in the U.K. and one of the biggest in the world.

Conbit said it is providing the specialist offshore engineering for parent company ALE, who has been contracted to provide the marine transportation, sea-fastening, load-out and ballasting of over 100 TPs for Ørsted's Hornsea Project One in the North Sea, set to be the biggest wind farm in the world.

For the structural engineering, Conbit used its internal structural engineering expertise to conduct the structural integrity and sea fastening calculations of the grillages on the barge deck.

Once on the SARAH S barge, ALE's latest marine investment, the TPs will be transported on the River Tees to the discharge berth. Conbit also provided the engineering for cost-effective storage and SPMT stability during the ALE transport operations at the yard.

For the storage at the quay, Conbit designed monopile cradles. These were specifically optimized to reduce costs, as the need for welding works is reduced.

As ensuring stability during the SPMT move was challenging, Conbit provided the engineering to enhance the hydraulic stability during the monopile positioning in relation to the sling configuration used for loading onto the SPMTs and positioning within the support cradles.

www.conbit.eu

Satellite Derived Bathymetry

TCarta said it delivered satellite derived bathymetry (SDB) to one of the world's largest oil and gas producers, Total SA, who will use the water depth data for preparing seismic survey works off the coast of Myanmar. The SDB dataset, which covered a 30-square-km area around Preparis Island in the Bay of Bengal, was generated by digitally extracting water depth measurements from multispectral imagery acquired by the European Space Agency's Sentinel-2 satellite. The resulting bathymetric data had a point spacing of 10 meters with measurements to a depth of 15 meters.

This process, according to TCarta CEO David Critchley, saves time and money. "Our processing team delivered the satellite derived bathymetry just a few weeks after Total placed the order," Critchley said. "Traditional airborne or shipborne bathymetric mapping would have taken several months and cost 10 times more." Total contracted with TCarta for the Preparis Island project following a benchmark study that also generated bathymetric data from Sentinel-2 imagery. Another TCarta product used in offshore hydrocarbon exploration and production is the Global GIS Bathymetry Package. This GIS-ready dataset provides a level of marine information superior to public-domain data for areas throughout the world. The 90- and 30-meter products each contain a Digital Bathymetry Model with spot-depth values, contour lines and high-resolution shorelines derived from multiple data sources.

www.tcarta.com

Photos:Valeport

Valeport Unveils New Probe

A new probe that combines the power of the SWiFT SVP and a turbidity sensor has been launched by British oceanographic and hydrographic instrument specialist Valeport. The new SWiFTplus uses Valeport's high accuracy sensor technology which incorporates turbidity observations with sound speed, temperature and pressure sensor technology to also provide computed conductivity, salinity and density. This is coupled with Bluetooth connectivity and a rechargeable battery. The handheld profiler, constructed from Titanium, has been designed from the outset with the intention of a seamless workflow and has an integral GPS to geo-locate every profile. SWiFTplus is intended for coastal, harbor and inland environmental and hydrographic survey use. Valeport's new turbidity sensor addition is effectively two sensors in one. The first is a "classic" turbidity sensor (nephelometry using a 90˚ beam angle) for low turbidity levels (0–2000 NTU) and the second uses an OBS optical backscatter arrangement (~120˚ beam angle for optical backscatter) at high turbidity levels (>20,000 NTU). Intelligent sampling eliminates the need to gain switch at higher turbidity levels.

Using a 'twist and go' switch on the unit, data can be quickly downloaded, reviewed wirelessly via Bluetooth, using the new Valeport Connect app, allowing data to be instantly shared in industry standard formats through email and cloud services. Valeport's new Connect software is also available on PC and can be used with a USB cable for instrument setup, data extraction, display and translation to common-format data strings and additional tools. Designed specifically for the operation of SWiFTplus and new to market Bluetooth enabled products, the new software simplifies and streamlines operation and data download tasks. Valeport Connect offers download capability with data translation and, once downloaded, allows both current and historic data to be visualized. Multiple profiles can be compared in graph view, while graphs can be further shared via email or cloud services. The SWiFTplus is now available to order.

www.valeport.co.uk

RED Engineering

New Clamp Tech for Subsea Well Intervention

New clamp technology developed by RED Engineering promises to improve subsea well intervention operations.

The two, first of a kind modular subsea clamps have been delivered to TechnipFMC for operation from the specialist well intervention vessel Island Constructor.

The modular design will allow the capacity of the clamps to be adjusted for both shallow and deep-water operations, providing TechnipFMC with a flexible solution for use across a range of well intervention projects, RED Engineering said.

The U.K. based firm has been working with TechnipFMC for over 10 years and completed this latest project in under six months. This included the design, build and testing of the clamps on a turnkey basis, with RED's in-house test facility being used for rapid proof of concept and factory testing prior to delivery.

The project offered a challenge to produce a pair of adaptable clamps that would safely retain two side-by-side umbilical cables, said RED's engineer, Mike Stobbart.

"As with previous clamps, these new ones feature spring applied pads to ensure a consistent and reliable clamping force is applied to the umbilical," Stobbart said. "However, we have now added a hydraulic actuation system to improve the efficiency of deployment."

www.redengineers.co.uk

Rovco to Launch Live 3D Subsea Technology

Rovco said it is set to launch its advanced live 3D subsea survey system. Following two years of R&D, the new technology is ready for field trials. The system has been developed to effectively manage the increasing complexity of subsea operations, using real-time 3D vision and AI data analysis to cut the cost of underwater inspections and maintenance.

The launch is made possible by a $1.6 million investment from three U.K.-based investment houses, Green Angel Syndicate, Cambridge Angels and Bristol Private Equity Club. The funds will see Rovco bring its latest inspection technology to the global energy market.

To meet an increased market demand for subsea inspection around offshore windfarms, pipelines and cables, Rovco also plans grow its headcount from 10 to 30 employees within the next year and add three new ROVs to its fleet within the next six months.

www.rov.com

Rovco

Textron

MacArtney

Autonomously Operating Winches for Naval USVs

U.S. based aerospace and defense development and manufacture company Textron Systems Unmanned Systems has taken delivery of new purpose-built autonomous launch and recovery winch systems specifically designed for the high-endurance Common Unmanned Surface Vehicle (CUSV).

The custom-engineered winches were designed, manufactured, assembled, tested and delivered by MacArtney to adapt to Textron Systems' specific requirements.

In designing the winches, MacArtney said it placed special emphasis on tailoring the design and features to the conditions that they will be experiencing throughout their service lives. They are designed and engineered for optimal durability and comply with the MIL standard 901D for shock and vibration.

Additionally, the winches' modular and compact design allows for flexible system installation on USVs, which are used to autonomously sweep, localize and neutralize mines and other explosive devices without human interaction. In addition to mine countermeasure application, the USVs may target a wide range of commercial applications, too.

The winches are made of aluminum and special alloys, which make them lightweight and corrosion resistant. In terms of pull force/winch weight ratio, this will also allow for added vehicle fuel capacity.

www.macartney.com

TE SubCom Launches Ocean Control Suite

TE SubCom introduced its Ocean Control suite, a technology the company says represents a leap forward in network control efficiency through software-defined networking (SDN). By enabling automated control over all parts of a communications network, the Ocean Control suite offers extensive remote programmability and control of an entire communications network, both terrestrial and undersea. The suite uses RESTful application programming interfaces (APIs) with read and write functionality to interface with undersea network elements like Wavelength Selective Switch Reconfigurable Optical Add Drop Multiplexer (WSS ROADMs). SubCom partner Ciena is among the first to take advantage of the new API capabilities, which was demonstrated to a select audience in Ciena's Ottawa labs throughout May. The first release of Ocean Control is available now with the full support of SubCom's enhanced Line Monitoring System (eLMS). Two additional releases are anticipated later this year that will further expand and enhance the Ocean Control suite's functionality to cover all major wet and dry network elements.

www.te.com

FORECASTS AND MARKET INTELLIGENCE FOR THE GLOBAL FLOATING PRODUCTION MARKET

THERE IS NOTHING ELSE LIKE IT ANYWHERE ELSE!

This comprehensive business intelligence service and online database provides insider access to business and investment opportunities in the deepwater global floating production sector.

- **MONTHLY REPORTS ON FLOATER PROJECTS:**

100+ page monthly reports providing up-to-date details for current and planned floating production projects

- **2018/22 FORECAST OF ORDERS:**

An in-depth market analysis and five year forecast of orders for floating production systems

- **SEARCHABLE DATABASE**

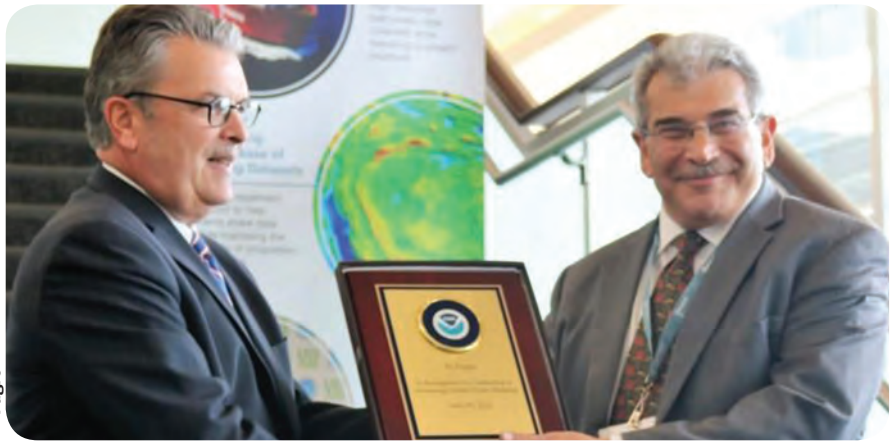
Internet accessible database with daily updated info direct from industry sources on current and planned deepwater projects

REQUEST YOUR SAMPLE REPORT AND A FREE FIVE DAY TRIAL:
VISIT WWW.WORLDENERGYREPORTS.COM OR CALL +1-212-477-6700

Fisher

Ocean Sonics

NOAA/Fugro: Craig McLean (l) of NOAA & Edward Saade, Fugro



Fugro

Fisher Joins Ocean Sonics

Rose Fisher has joined hydrophone manufacturer Ocean Sonics as Marketing and Public Relations Coordinator. Fisher brings to the role diverse experience having worked within Canada's environmental not-for-profit sector and internationally with SMEs and start-ups. Fisher has a Bachelor of International Business, a second Bachelor in Agricultural Science and an Advanced Diploma in Public Relations.

NOAA Honors Fugro

Fugro's global ocean mapping efforts have earned the company a formal commendation from the U.S. National Oceanic and Atmospheric Administration (NOAA). The recognition came during a recent industry briefing with Fugro and NOAA about The Nippon Foundation-GEBCO Seabed 2030 Project, a global initiative to map the world's oceans by the year 2030.

During this year's Ocean Technology Conference in Houston, McLean presented Fugro's USA President, Edward Saade, with a commemorative plaque on behalf of NOAA stating, "We asked for nothing and you're delivering a lot. We are very much appreciative of this and we wanted to commend and celebrate the work of Fugro in getting us to a better place, and in demonstrating the capabilities within the private sector for a larger public good."

Fugro's contributions to the Nippon Foundation-GEBCO Seabed 2030 project will be used to inform global policy, improve sustainable use and advance scientific research. Additionally, crowd sourced bathymetry data acquired by Fugro in the North Atlantic Ocean is feeding into a regional initiative known as the Galway Statement on Atlantic Ocean Cooperation. Signed in 2013 between the United States, Canada and the European Union, the statement provides a means for understanding the shared waters of the North Atlantic for scientific, environmental and economic benefits. The Galway Statement specifically references seabed mapping as an activity where cooperation will result in multilateral and mutual benefits.

The Underwater Center Under New Ownership

The Underwater Center, a subsea training and trials center located in the Scottish Highlands, has turned a corner after receiving industry support to secure its future.

Industry and public bodies including Oil & Gas UK, Subsea 7, TechnipFMC, Premier Oil and Highlands and Islands Enterprise (HIE) have collaborated to support The Underwater Center. The company will now operate as a not-for-profit company limited by guarantee, which will be funded and supported by its members, comprising operators, service companies and industry. The new restructured company formally began operating on May 7, 2018

The Underwater Centre is a purpose-built subsea training and trials facility and is based on the shore of Loch Linnhe, sheltered by the surrounding mountains. The center's unique location allows it to provide year-round training and testing in an open-water environment, while still being centrally located in Fort William, the largest town in the Scottish Highlands.

University of Limerick Buys ROV for Renewables Research

The University of Limerick (UL) will deploy a brand new remotely operated underwater vehicle (ROV) to support its research into subsea inspection and intervention campaigns on renewable energy sector infrastructure.

The new underwater vehicle, a Comanche 2,000 meter observation class ROV designed and manufactured in-house at Forum Energy Technologies' Kirkbymoorside Yorkshire facility, was officially launched at the docks in Limerick City by Minister of State for Trade, Employment, Business, EU Digital Single Market and Data Protection, Pat Breen TD. The ROV is equipped to a high specification with precision positioning and navigation systems, camera and lighting systems and sonars. The systems will be used as a test bed for research to develop capabilities for inspection, maintenance and repair work on Marine Renewable Energy (MRE) infrastructure in the challenging strong wave and current conditions at MRE test-sites and offshore MRE sites in Ireland and further afield. The ROV system is home ported at Limerick Docks in the Republic of Ireland.

The Underwater Centre

The Underwater Centre

Researchers at UL's Center for Robotics and Intelligence Systems (CRIS) further enhanced the system with UL-developed advanced control software (OceanRings), precision navigation and flight control, state-of-the-art robotic imaging and sonar systems and fully automated manipulator systems.

University Buys ROV

Forum Energy Technologies

The vehicle will be housed at Limerick Docks where experimentation, testing and demonstration will be carried out. It will also be mobilized on vessels at other ports in Ireland.

Resen Waves Raises $1.3m

Danish renewable energy technology company Resen Waves said it has raised $1.3 million capital through West Hill Capital. The company, which has developed a standalone small-scale wave energy device called the Resen Waves Power Buoy, said the new capital will be used to establish sales and marketing operations in Aberdeen focused on the

Resen Waves

Resen Waves

MDL

MDL

Subsea 7's Seven Viking

Subsea 7

Kraken's Katfish-M

Kraken

offshore oil and gas sector as well as to further research and product development in Denmark.

MDL Awarded Umbilical Installation Project

U.K. based Maritime Developments said it has won a flex lay contract on a major gas field in the Mediterranean Sea. The project, due to start in 2019, will cover installation of an umbilical connecting the production wells to a fixed offshore processing platform.

The work will be carried out using MDL TTS-4/310 Series Tensioner, a 110-metric-ton unit, operated by MDL personnel, as part of the MDL Offshore Service.

Statoil Awards Contract for Subsea 7's Seven Viking

Subsea 7 S.A. said it has received a contract from Statoil to provide subsea inspection, maintenance and repair (IMR) services on the Norwegian Continental Shelf. Subsea 7 did not specify a dollar amount for the awarded work, but said the contract is worth between $150 and $300 million. Offshore activities will begin in January 2019 using Subsea 7's IMR and light construction vessel Seven Viking, built at Norwegian shipyard Ulstein Verft in 2013.

The contract involves the provision of a life of field support vessel Seven Viking for five years, with options for extensions. The vessel, complete with work class and observation class remotely operated vehicle (ROV) and a module handling support system, must be capable of performing standard inspections, light construction and scale squeeze operations, as well as module handling and Christmas tree installation.

Project management and engineering support will be executed from the offices of Subsea 7 company i-Tech Services in Stavanger, Norway.

Kraken Achieves Military Standard Certification

Kraken Robotics Inc. subsidiary Kraken Robotic Systems Inc. has completed military standard certification testing of the KATFISH-M, a ruggedized version of Kraken's KATFISH Towed Synthetic Aperture Sonar Platform.

KATFISH-M incorporates a state-of-the-art Synthetic Aperture Sonar (SAS) in a compact, lightweight and hydro-dynamically stable towed body. It uses advanced signal processing and algorithms to provide real-time, detection and classification against underwater mine threats. KATFISH-M was tested and certified by independent laboratories on a variety of U.S. Department of Defense military ruggedization standards known as MIL-STD-810G and MIL-STD-461. The MIL-STD-810G focuses on environmental engineering and requires products to pass a series of laboratory tests to ensure that military equipment can operate in extreme worldwide environments. The MIL-STD-461 standard covers the requirements and test limits for the measurement and determination of the electromagnetic interference characteristics (emission and susceptibility) of electronic, electrical, and electromechanical equipment.

The commercial version of KATFISH is priced at $1.5 million, while the military certified version, KATFISH-M, is priced at $2.5 million. Both systems are available now.

Peruvian Subs Set to Receive New Static Converters

ECA Group said it has been awarded a contract under the Peruvian Navy's submarine modernization program.

ECA Group signed a contract with the shipyard SIMA and the Peruvian Navy for the replacement of the 16 units of static converters 115V / 400Hz and 115V / 60Hz aboard four type-U209 v.1200 submarines: BAP Angamos (SS 31), BAP Antofagasta (SS 32), BAP Pisagua (SS 33) and BAP Chipana (SS 34).

Peru decided to upgrade four of its Type 209 submarines in 2015 and commenced the nearly seven years long modernization program in 2017.

The modernization work, which includes hull separation and modernizing or replacing the command and control systems, will allow the Peruvian Navy to keep its current submarine force for another 15 years as it works toward the planned acquisition of new generation submarines around 2035. ECA Group said its static converters are installed aboard several French submarines and have also been supplied to other navies in Southeast Asia.

marine technology SOCIETY
Opportunity runs deep™

OCEANS
CONFERENCE & EXPOSITION

IEEE OES Oceanic Engineering Society

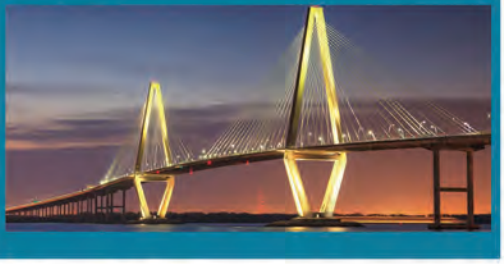
October 22 - 25, 2018 | Charleston, SC | charleston18.oceansconference.org

Healthy Oceans, Resilient Communities, Robust Commerce... Strong Nations

REGISTRATION OPENS IN JUNE!

OCEANS 2018 Charleston will be held October 22-25 in the historic and coastal town of Charleston, SC. The theme will draw strongly on local, regional, and international issues of interest, including how science and technology must inform and enable the challenges of a 21st Century where environment, society, and economics are highly interconnected.

- HEAR FROM INNOVATIVE THOUGHT LEADERS
- CONNECT WITH CUTTING-EDGE TECH PIONEERS
- MAKE DEALS WITH BUSINESS SUPPLIERS
- SUBMIT A TUTORIAL OR WORKSHOP PROPOSAL
- REACH DECISION MAKERS & INFLUENCERS



PARTICIPATE IN THIS YEAR'S BRAND NEW EXHIBITOR TRACK!

From corporate presentations to themed roundtables, attendees can engage in intentional conversations with exhibitors and vendors regarding relevant industry topics, challenges, technologies, and trends.

MTR Marketplace

PRODUCT, PROFESSIONAL, VESSELS, BARGES & REAL ESTATE FOR SALE

Advertiser Index

Page	Company	Website	Phone#
5	BIRNS, Inc.	www.birns.com	Please visit us online
21	Blueprint Subsea	www.blueprintsubsea.com	+44 (0) 1539 531536
15	Deep Ocean Engineering, Inc.	www.deepocean.com	(408) 436-1102
11	DeepSea Power & Light	www.deepsea.com/apex-seacam	(800) 487-3775
C3	EvoLogics GmbH	www.evologics.de	49 30 4679 862 0
47	Greensea Systems, Inc.	www.greenseainc.com	(802) 434-6080
3	Hydroid, Inc.	www.hydroid.com	(508) 563-6565
13	JW Fishers Mfg Inc.	www.jwfishers.com	(508) 822-7330
31	L3 OceanServer	www.ocean-server.com	(508) 678-0550
19	NAUTILUS Marine Service GmbH	www.nautilus-gmbh.com	49 4161 55903-0
62	Oceans 2018 Charleston	http://charleston18.oceansconference.org	Please visit us online
41	R.M. YOUNG COMPANY	www.youngusa.com	(231) 946-3980
25	R.W. Fernstrum & Company	www.ferstrum.com	Please visit us online
C4	Riptide Autonomus Solutions, LLC	www.riptideAS.com	(617) 820-4586
9	RS Aqua Ltd	www.rsaqua.co.uk	+44 (0) 1730 828222
7	Saab Seaeye Ltd.	www.seaeye.com	Please visit us online
1,17	SBG Systems	www.sbg-systems.com	Please visit us online
C2	Shark Marine Technologies, Inc.	www.sharkmarine.com	(905) 687-6672
23	Silicon Sensing Systems Limited	www.siliconsensing.com	+44 (0) 1752 723368
45	SubCtech GmbH	www.subctech.com	+49 (0) 431-22039 884
59	Undersea Defence Technology	www.udt-global.com	Please visit us online
57	World Energy Reports	www.worldenergyreports.com	(212) 477-6700

The listings above are an editorial service provided for the convenience of our readers.
If you are an advertiser and would like to update or modify any of the above information, please contact: productionmanager@marinelink.com

EvoLogics®

SMART SUBSEA SOLUTIONS

S2C TECHNOLOGY: COMMUNICATION AND TRACKING COMBINED

- time, space and cost-saving solutions
- low power consumption for autonomous operations
- advanced data delivery algorithms, addressing and networking, remotely configurable settings
- extendable platform with multiple configuration options: power-saving Wake Up module, acoustic releaser, additional sensors, custom solutions, OEM versions availableh

USBL POSITIONING SYSTEMS

simultaneous positioning and communication - no need to switch between positioning mode and modem mode

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: up to 0.04 degrees

LBL POSITIONING SYSTEMS

highly accurate, precise and stable performance, simultaneous positioning and data transmissions

- flexible SiNAPS positioning software
- reliable data transmissions
- range: up to 8000 m
- accuracy: better than 0.01 m

UNDERWATER ACOUSTIC MODEMS

reliable data transmissions even in adverse conditions, customizable R-series modems, light and compact M-series "mini" modems, **new S2CM-HS high-speed modem**, special editions for developers, S2C communication and positioning emulator - remote access or standalone device

- range: up to 8000 m
- depth: up to 6000 m
- data rate: up to 62.5 kbps

Meet us at
UNDERSEA DEFENCE TECHNOLOGY 2018!
June 26 - 28, 2018
Glasgow, UK
Stand B6

EvoLogics GmbH
Ackerstrasse 76,
13355 Berlin, Germany

tel.: +49 30 4679 862-0
fax: +49 30 4679 862-01

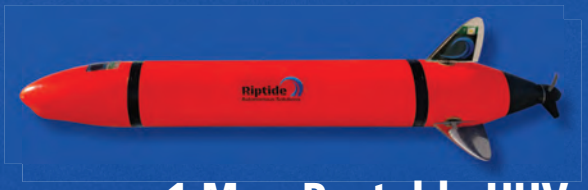
sales@evologics.de
evologics.de

Riptide set out to change the undersea vehicle market by combining best in class hydrodynamics, ultra low power processing, and game changing new energy technology, while significantly reducing vehicle costs. To accomplish this, we introduced the small, yet highly-capable micro-UUV.

And now, the Family just got BIGGER

Introducing the Riptide Family of Low-Logistics, Man-Portable UUVs

Micro-UUV
4.875" Diameter
~25 lbs
300m rated



1 Man-Portable UUV
7.5" Diameter
~65 lbs
300m rated

2 Man-Portable UUV
9.375" Diameter
~120 lbs
600m rated

Riptide
Autonomous Solutions

Email: info@RiptideAS.com • **Website:** www.RiptideAS.com
Phone: +1 617-820-4586 • **Address:** 36 Cordage Park Circle, Suite 330, Plymouth MA, 02360