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Synchro Guiding Emerging Tech to Market

Massa Generations of Subsea Innovation

AI What Does it Mean for Science?

NATO Gains Unmanned System Experience

Seafloor Mapping ROVs in Photogrammetry Projects


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On the Cover

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Editorial

Justin Zuure

I sit back in amazement at how technological evolution in this industry continues to pick up speed, as things like Artificial Intelligence – with all of its promise and peril – continue to evolve and penetrate subsea tech solutions. As anyone reading these pages can attest, the ability to work efficiently, effectively and safely on, under and around the world's waterways is arguably one of the most challenging. This month I'm pleased to highlight two stories that I think embody ingenuity – and needs – in the sector.

Massa Products Corporation is no stranger to the subsea space, as the company – led by third-generation leadership in the form of **Dawn Massa Stancavish** – builds upon the legacy that started with **Frank Massa**, a man who pioneered the field of electroacoustics, more than 75 years ago; carried forward by **Don Massa** until the leadership baton was earned by his daughter. Dawn is passionate about her company, technology and people, and it is the latter that I found most interesting in our recent interview. Through our channels, we talk relentlessly about the innovations, the technology that make this industry special. But behind technology are people, and today there is a decided shortage of tech talent that is needed by Massa [+ every other company reading these pages] to power its future. Dawn and her team are active participants in local, regional and national initiatives – such as **buildsubmarines.com** – that are geared toward informing, attracting and retaining the next-generation that is so desperately needed to power the future of subsea technology. Read our interview with Massa starting on page 30.

The other story I found of particular interest was my interview with **Henry Ruhl** and **Amy West** of Synchro. Synchro is a program designed to help take subsea technology from the workbench to commercialization, a process that has always fraught with hurdles and sinkholes. It is a co-designed testbed to synchronize and evolve tech solutions, free to anyone globally who qualifies; helping technology and its developers navigate the *'Valley of Death'*. Our interview with Synchro starts on page 26.

Gregory R. Trauthwein
Publisher & Editor

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Qinertia

The Next-generation INS/GNSS Post-processing Software

Data Sheet

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	Long GNSS Outages Handling	Easy & Powerful Exporter
Log duration: 2h15 Processing Time: < 2 mins	Example: up to 80 seconds *outages and multi-path effects* 95% positions < 2 cms Max error < 30 cms	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

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Kevin Hardy is President of Global Ocean Design, creating components and subsystems for unmanned vehicles, following a career at Scripps Institution of Oceanography/UCSD. He holds patents in the field of ocean landers. He is on the academic advisory board of Instituto Milenio de Oceanografía at the Universidad de Concepción, Chile. Hardy received an honorary Doctor of Science degree from Shanghai Ocean University in 2018. He proposed making thick wall glass spheres to Nautilus Marine Service/Vitrovex (Germany) that opened the hadal depths to routine exploration. He writes for the *Journal of Diving History* and the *MTR*.

AI IS COMING …

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... WHAT DOES IT MEAN FOR SCIENCE?

By Huw Gullick, Associate Director, NOC Innovations

My family and I have recently moved house. I'm at that classic time in life when needs are changing; bigger garden for the kids, spare room for the parents to stay in and larger lounge so the dog has his own sofa. When we moved in my eldest son chose his bedroom – much bigger than in the old house – and I asked him what he was going to do with all the space. "This area is for my digital lab," was the response (and here is me thinking that he could have shelves for all his Lego). Intrigued, but secretly thinking I could catch him out, I asked; "what's a digital lab?". The look of disappointment on his face; "What!? Like machine learning, AI, digital twins, stuff like that. How old are you dad?" Truly beaten by an 8 year-old, I went back downstairs to my typewriter – you know, the thing that you hit letters and it prints them on this stuff called paper.

I put my son talking about "digital labs" down to just being a sign of the times. The ease and fluidity with which young people can navigate the digital world we live in is incredible. Scary, but incredible. The way we think, act and work are in a much more digital way. From paperless utility bills to tools like ChatGPT, we can't avoid interacting with something digital. This digital integration has been happening for many years and it doesn't seem to be stopping anytime soon. I exist in a science research world, and we are grappling with what this means for us; will it help us? What skills will we need? What do we do with all this data? These are just a few of the questions we are continually asking ourselves. In particular, we focus on AI. AI is something that has huge potential for science but it's complicated stuff. I'm sure my son would instantly understand it all but for me, I'm still confused. Oh, and by the way, if you're interested, I'm 38.

Let's start with some context and definitions. AI-based approaches to tasks or activities isn't something new, they have been around for decades. Indeed, the birth of AI can arguably be traced back to the 1950s. Practical examples include such things as computer-aided vision from the 1970s. What we are seeing now is the widespread impact of AI through the pace of its development, the scale it has achieved and how it has permeated into everyday life.

It is also necessary to at least try and define, or constrain, what we mean by AI. For me, it's relatively simple; AI is used extremely broadly, and covers a huge range of goals and techniques, but I think of AI as an artificial system that does tasks usually associated with an intelligent being (mostly, a human). Terms such a "digital twin" or "machine learning" are ways to achieve artificial intelligence. In the case of machine learning, you don't program the intelligent algorithm directly into the computer. Instead, you show it a large number of examples and (with some constraints) the computer learns the algorithm for itself (e.g., how to recognize faces). Not all AI applications use machine learning though; think traditional chess-playing computers that use brute-force computation, but still behave "intelligently". So, it's a complex space with different types and layers of AI-based approaches and new approaches emerging that have capabilities with significant impact. Generative AI is something that has exploded more recently and is both exciting and concerning. ChatGPT and deepfakes fit into this category. I struggle to navigate the technical complexities of AI and keep pace with the rate of technological development, but I can see its increasing use in the scientific fields and if I was to stick my neck out, I would say it is potentially game-changing. Let me try and unpack this. As an ocean science research organization, the National Oceanography Centre (NOC) relies on ocean data for what we do. Understanding the ocean is reliant on gaining data from it, and lots of it. In its most simplistic form, AI can allow us to capture, process and interpret data quicker and at a higher rate. Think of ocean science research as a journey to answer a question. Along that journey we undertake a range of activities; we define the data we need to capture, the tools we need to capture it – usually a research vessel, autonomous equipment, satellite data, etc – then we build it. We then go and collect the data, process it, analyze and interpret it to draw scientific conclusions. What drives this journey forward are human based activities and decisions; thousands of them. AI offers us the opportunity to swap human led activities and some of the limitations we have, with an AI-based approach. Think about the data collection stage in the journey, we could swap a human physically looking at the environment, piloting equipment to look at it or working through thousands of images to identify specific species with computer vision, robots, or species recognition algorithms. For me, the power and success of AI therefore comes down to three things;

1. How many human-led activities or decisions can be replaced by AI?
2. Whether it can beat a human; can it do it quicker and more accurately, etc?
3. Whether it is cheaper or as a minimum, the improvements it offers are of value

I'd also argue there is a fourth point around whether it crosses an ethical boundary in undertaking the first three points but that is a conversation for a different day.

From a science perspective, these three, rather obvious points, open up a world of possibilities. Some of the reasons why we are interested in AI include its ability for consistent accuracy through robotic control, accepting some inaccuracies in exchange for speed and performance can lower costs for some activities and the fact that, from an ocean science perspective, AI is computationally cheaper than a traditional physics-based approach. We have a large "Digital Ocean" function in our organization who work closely with other scientists to develop AI and machine learning applications in a range of areas such as image processing from satellites and underwater vehicles, data curation and quality control, hybrid modelling where we replace computationally-expensive parts of a simulation with a cheaper statistical emulation and the control of robots for use in autonomous data capture systems.

When I talk to colleagues involved in this work it feels like we are nearing the point where we can scale this up to achieve significant impact in our work. But I always return to the question of "so what? What does this give us?". For me, AI has to have impact and transform the way we do something so we can do more or make our science more accessible. If we can develop AI-based techniques that allow us to process more data, more accurately and quicker then theoretically this allows us to undertake more science. More science means more understanding of our ocean and this is a good thing. When we step into the world of data visualization through AI then this opens up a new channel to communicate data and science in a way that people can interact with through things such as augmented reality and virtual reality. This democratizes complex science by translating it into something accessible to non-scientific audiences. These are just some examples of what is possible but there are many more.

However, before we get carried away, a word of caution. AI can have some downsides, and in a scientific world where accuracy is king for drawing conclusions this can be challenging. Machine learning in particular requires a large amount of "training" data or observations which we often don't have. The training step can be very laborious and is often where the main costs of AI lie. AI algorithms can sometimes produce really inaccurate results, and this can be particularly dangerous when they look sensible or reasonable. And finally, there is the big one; AI based approaches are sometimes seen as "black boxes" and are therefore not trusted. People don't understand what is going on in the box and can jump to nightmares of killer robots wandering around completely uncontrolled. The growth in "explainable AI" is trying to allay these fears by letting us probe more into how the AI is working in the box.

This all said, I think the science community will need to relax a bit more about the use of AI. People often pick on the above objections as a way to reject AI techniques, but the "traditional" techniques are sometimes no more accurate. The weather forecasting community is going through this challenge at the moment – it was assumed that the traditional physics-based models would always win, but some AI-based models are gaining serious traction for attacking particular problems (e.g., short-term forecasting).

I recognize I have given the characteristically "political" view here; the pro's, the con's and no definitive answer. Let me try and give you a shorter answer to the question. Firstly, here is some context for my answer; we can't see AI in the science world in the same way as we do in our everyday life or through the same lens as it is often presented by the media. It's much more about the technical mechanics of how it is built and used within the scientific process. Seen in this way, my personal opinion is that science will become increasingly enabled by AI approaches, but it requires close contact with the mathematical and computational experts to ensure that the right techniques are chosen, and the right conclusions drawn. It's very easy to get into a "Wild West" of people throwing around algorithms and data and coming up with nonsense results. If we do this, we undermine the potential of AI in the scientific methodology and this fuels the skepticism of it as a tool that can fundamentally change how we "do science".

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Huw Gullick is Associate Director at NOC Innovations. His role involves finding real life application for the technology, science and wider capability of National Oceanography Centre's research.

DEEP DATA: CYBERSECURITY IN THE SUBSEA DOMAIN

By David Strachan, Defense Analyst and Founder of Strikepod Systems

A rogue nuclear program is sabotaged by a highly advanced computer worm. Malware targeting an Eastern European economy spreads throughout the world causing collateral damage. A major Middle Eastern port descends into chaos after a crippling cyberattack. A U.S. adversary captures an advanced surveillance drone by forcing it into autopilot and spoofing GPS signals. Off-the-shelf quadcopter drones are used to hack into smartphones and corporate wireless networks.

While these may sound like plotlines from popular techno-thrillers, they are, in fact, actual, real-world events, and just a few examples of increasingly numerous, sophisticated, and devastating cyber operations. From spearfishing, to ransomware, to zero day exploits, cyberattacks are on the rise, with their effects being felt across the public and private sectors.

In recent years, maritime cybersecurity has garnered increased attention, as high-profile attacks such as NotPetya and Shahid Rajaee (alluded to above) have underscored the vulnerability of commercial maritime operations, as well as their threat to global security. With the gradual integration of autonomous air, surface, and, increasingly, subsea systems into maritime operations, matters are becoming even more complex. Vehicles, sensors, as well as underwater energy, communication, and data transfer infrastructure are all potential threat vectors that can be used by malicious actors to inject cyber payloads into broader operational networks. Moreover, as operational technology (OT), these platforms themselves are vulnerable to cyberattack. This has implications for commercial and scientific entities integrating subsea systems into their operations, as well as maritime security and defense players, particularly for the U.S. Navy as it moves toward operationalizing Distributed Maritime Operations (DMO).

To date, the focus of commercial maritime cybersecurity has been securing against threats to the web of port navigation, communication, and cargo handling OT. But ports and offshore entities are also increasingly automating their inspection and security operations using unmanned surface vehicles (USVs), remotely operated vehicles (ROVs), and underwater intruder detection systems (IDS), the compromise of which could provide an attacker with access to OT, or enable kinetic attacks resulting in significant economic disruption and geopolitical instability. While such systems may appear to be "air gapped" (buffered against passive cyberattack), by providing WiFi or RF connectivity to a remote location, these systems would be vulnerable to attack. For example, many COTS ROVs integrate with WiFi-enabled laptop computers or WiFi and Bluetooth-enabled smartphones, using them for C2, video, and data processing. If a wireless-enabled ROV inspection

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system is integrated into a patrol vessel's C2, the entire port security network, and, by extension, possibly the larger port C2 system, is then vulnerable to attacks originating within the ROV. (Conversely, the ROV would also be vulnerable to attacks originating within the port's C2).

While the commercial maritime sector grapples with its own cybersecurity challenges, naval and maritime security entities must grapple with similar threats and vulnerabilities. Securing both classified and unclassified networks against intrusion is of course paramount. A compromised network used during manufacturing, testing, or maintenance, for example, could enable an adversary to install malware designed to transform an AUV or sensor into a malicious node. Once deployed, the node could gather data and intercept communications, and then exfiltrate the data via covert surface communication. Malware could also make its way from the infected vehicle onto a manned submarine during integration with shipboard systems. Speaking in 2014 before the Naval Submarine League, then NAVSEA commander Vice Adm. William Hilarides addressed the serious risk posed by offboard networks to submarines, particularly in light of their nuclear power and payloads. As submarines increasingly deploy, interact with, and recover vehicles and seabed infrastructure, the vulnerability of crewed undersea platforms to cyberattack will increase dramatically.

To date, the focus of commercial maritime cybersecurity has been securing against threats to the web of port navigation, communication, and cargo handling OT.
But ports and offshore entities are also increasingly automating their inspection and security operations using unmanned surface vehicles (USVs), remotely operated vehicles (ROVs), and underwater intruder detection systems (IDS)

With the proliferation of vehicles and sensors, the undersea domain will no longer be a sanctuary for crewed submarines. As such, Navies will need to employ, as well as detect and counter, tactical and operational deception, and this will be enabled by cyber operations.

This may take many forms, such as Position, Navigation, and Timing (PNT) attacks (e.g. GPS spoofing), which can result in false location readings for surfaced AUVs, risking mission failure or vehicle capture. Or man-in-the-middle attacks, wherein a malicious underwater network node impersonates a friendly node to intercept data, disrupt communications, or poison the data stream. And as artificial intelligence makes its way into subsea operations, systems will be vulnerable to AI manipulation attacks. Poisoning a mine countermeasures image recognition dataset, for example, might cause an AI to identify ordinary organic objects as live ordnance, or, conversely, classify actual mines as benign.

And cyberattacks don't necessarily need to involve lines of code. Kinetic attacks against subsea cyber infrastructure could be just as damaging, if not more so, as the physical destruction would significantly prolong mitigation and recovery. The vulnerability of transoceanic cables to sabotage is well established, as events in the Baltic Sea continue to underscore. Seabed server farms, an innovative solution to data center cooling pioneered by Microsoft's Project Natick, would also be vulnerable to physical attacks using "undersea IEDs" fashioned from AUVs or ROVs.

So how can the subsea community defend against these threats? Current threat intelligence is essential, as is network surveillance, "cyber hardening," and robust anti-tamper technologies. Given the sheer number and adaptability of malicious cyber actors, resilience - the ability to quickly detect, mitigate, and recover from cyberattacks - is key, as is leveraging professional "ethical hackers" to conduct network penetration testing ("pen testing") to identify system vulnerabilities. In addition to these approaches, an active defense posture may work as well, such as deploying digital twins or cyber decoys to detect malicious network activity and deceive attackers, luring them away from true operational networks.

The proliferation of subsea vehicles, networks, and infrastructure will inevitably give rise to new cyber threats and open up new attack vectors to malicious actors. It is critical to anticipate how cyber operations could unfold in this unique and challenging environment, as well as the broader operational and strategic challenges they will present.

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THE CURIOUS CASE OF THE 1,200 MW TRANSMISSION SIZE "LIMIT" IN NEW ENGLAND

How the Maximum Contingency of 2,200 MW Was Recast to a 1,200 MW Ceiling

By K&L Gates partners Theodore Paradise, Kimberly Frank, and Ruta Skučas

As policy makers and energy developers look to develop and interconnect large offshore wind projects in the most economically efficient and least environmentally impactful way, an issue has developed. A relatively recent limit, set in place by the grid operator in New England in a planning process document, states that no single system loss of energy, or "contingency", can be larger than 1,200 megawatts (MW). This 2016 addition to ISO New England's (ISO-NE) Planning Procedure No. 5-6 is increasingly creating consternation among both policy makers and developers and threatening to raise the cost and impacts of offshore wind. Part of the reason is that a de facto standard has developed in Europe that utilizes 2,000 MW 525 kilovolt (kV) high voltage direct current (HVDC) cable systems to interconnect offshore wind, with tens of billions of dollars of these systems already ordered and scheduled to be in service by the end of this decade. The 2,000 MW size allows for single wind projects to be larger and benefit from economies of scale spread over more power production per project and significant reductions in the number of HVDC transmission systems needed to connect these projects to the grid. To meet New England's projected need of 30,000 MW of offshore wind power, 10 more HVDC cables and associated converters at several hundreds of millions of US dollars each would be required if the 1,200 MW single source limit continues to apply.

At the same time, the complex and opaque history of the 1,200 MW limit has led to the impression that this has been a long-standing ceiling in the region and a sense that it would be a significant effort to lift the limit. If the 1,200 MW ceiling is relatively recent, what is the long-standing single source New England loss limit agreed to by the predecessors of the New York Independent System Operator (NYISO), ISO-NE, and PJM Interconnection (PJM) in 1991? 2,200 MW. Instead of a ceiling, the 1,200 MW is a floor that the three systems will redispatch power flows on their system to maintain.

The 1991 agreement, the "Procedure to Protect for the Loss of Phase II Imports," set 2,200 MW as the single source loss ceiling and established a process for assessing conditions in the NYISO and PJM systems through an examination of seven reactive conditions. In PJM, this consists of power flows across three specified lines, and in NYISO, there are four monitoring points consisting of voltages at three substations and power flows on the Central East Interface. Any restriction below the 2,200 MW level down to 1,200 MW, and any point in between, is an at least hourly calculation involving a control-to-control room check. The 1,200 MW value does not appear in the 1991 agreement, but is observed by the three grid operators as the lower limit under which system operators will redispatch generation to maintain. The 1991 agreement was filed with the Federal Energy Regulatory Commission (FERC) in Docket No. ER07-231-000 on an "informational" basis in November of 2006 because it did not contain "rates, terms, or conditions" under the Federal Power Act (FPA). FERC rejected that informational characterization in its January 12, 2007 order, and accepted the filing under Section 205 of the FPA. The 1991 agreement can be found on the FERC website using the citation 111 FERC ¶ 61,017.

In practical terms, this means that, since 1991 until the present day, resources like the Phase II HVDC line from Canada to the United States that can operate at up to 2,000 MW, the Boston-based Mystic Generating Station units 8 and 9, which collectively are a 1,600 MW single source loss due to a common natural gas fuel source issue from an adjacent liquefied natural gas gasification facility, and the region's two remaining nuclear plants, Seabrook in New Hampshire and Millstone in Connecticut, can all operate above 1,200 MW and up to their limits as long as system generation dispatch and resulting power flows on the New York and PJM systems allow. The 2016 planning process limit only applies prospectively to new resources – HVDC lines interconnecting offshore wind included.

As more focus was placed on the 1,200 MW limit by policy makers and developers, in March of 2023, ISO-NE sent a letter to the Joint ISO/RTO Planning Committee requesting a coordinated study among ISO-NE, NYISO, and PJM to determine if the 1,200 MW limit could be raised. ISO-NE described the 1,200 MW design limit as a means to address the issue as one of "daily unpredictability" regarding the size of the single contingency limit under the 1991 agreement. In its letter, ISO-NE notes the size of larger resources could be "constrained by an otherwise optimal interconnection design," and asks the Joint ISO/RTO Planning Committee to assess the source limit

January 1, 1991
Review Date: 10/1/2006

PROCEDURE TO PROTECT FOR THE LOSS OF

PHASE II IMPORTS

Reference: Procedure to Protect for the Loss of Hydro-Quebec Exports

INTRODUCTION

The Hydro-Quebec/NEPOOL Phase II tie has maximum transfer capability of 2,000 MW. Joint PJM/NYPP/NEPEX studies have concluded that the loss of the Phase II facilities at high levels of imports could have a worse effect on NYPP and PJM than the worst internal contingency that these individual systems normally protect against. Accordingly, it has been agreed that Phase II imports will be limited to the extent necessary to insure that NYPP and PJM operation reliability criteria are not violated by the loss of Phase II contingency. This procedure is designed to prevent the occurrence of a loss of Phase II contingency applicable when Phase II is operated in the isolated or synchronous mode. The absolute maximum loss of Phase II contingency allowable under this procedure will be 2,200 MW.

The introduction of the 1991 Procedure to Protect for the Loss of Phase II Imports

to see if it can be increased. ISO-NE noted the upper limit for a single system contingency to be 2,000 MW -- instead of the stated 2,200 MW -- and sought study up to that lower 2,000 MW limit. While a 2,000 MW operating ceiling would accommodate the emerging offshore wind transmission standard set in Europe, it is worth noting that this is still 200 MW below the maximum level grid operators identified in 1991 and is contained in the ISO-NE tariff, the only upper limit in a document that has been reviewed and accepted by ISO-NE's regulator, FERC.

One interesting element of the ISO-NE request is that ISO-NE itself that has set the 1,200 MW ceiling as a design limit, not PJM or NYISO. The ISO-NE could similarly remove its self-imposed limit and instead abide by the hourly check-in set out in the 1991 agreement for new resources up to the 2,200 MW ceiling.

Regardless of the outcome of the exercise that ISO-NE has undertaken, policy makers and developers may also try and work around ISO-NE's 1,200 MW ceiling by ensuring that the loss of larger cables does not result in a simultaneous loss of more than 1,200 MW across the ISO-NE footprint. Suggestions from industry have included networking facilities from inception so that there are multiple paths for power to flow. The advent of HVDC breakers and commercial deployment of that technology in western European over the next five years may make the networked solution feasible, but the New England states will have to specify or agree upfront to networking in transmission requests for proposals and ISO-NE will need to confirm that additional transmission paths would address the single source loss issue.

Until one of these or another solution to address the lowered single contingency limit is adopted, offshore wind projects and transmission circuits in New England will likely continue to see limits of 1,200 MW.

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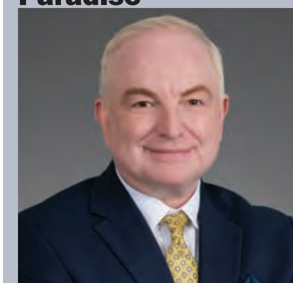

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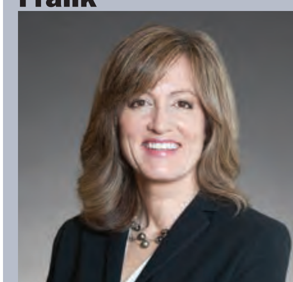
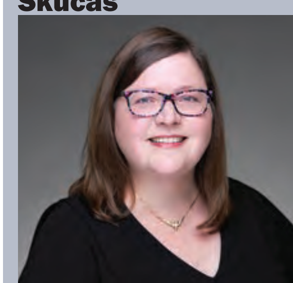
Frank



Washington, D.C., partner Kimberly Frank co-leads the firm's global Power practice group and focuses her electric regulatory practice on representing clients in matters before FERC and state utility commissions.

Skučas



Ruta Skučas is a federal energy regulatory and wholesale electricity markets partner in Washington, D.C., and advises clients on electric and natural gas matters before FERC, as well as ISOs and RTOs.

NATO GAINS EXPERIENCE WITH UNMANNED SYSTEMS

All photos courtesy NATO

By Edward Lundquist

NATO allies and partners have taken advantage of recent demonstrations and exercises to experiment and train with maritime unmanned systems that operate on, above and under the sea.

Led by host-nation Portugal, the REPMUS 23 (Robotic Experimentation and Prototyping with Maritime Unmanned Systems) took place between September 11 to 22 to focus on capability development and interoperability. REPMUS 23 segued into by the NATO-led exercise Dynamic Messenger 23, which focused on integrating Maritime Unmanned Systems into operations. Both took place in and around the Portuguese Navy's base on the Troia Peninsula.

Fifteen NATO nations participated in this year's exercise, which was conducted between Sept. 18-29, along with partners Ireland and Sweden. The exercise was co-organized by the NATO Centre for Maritime Research and Experimentation (CMRE) in La Spezia, Italy, the University of Porto's Laboratory for Underwater Systems and Technology (LSTS), and NATO's Maritime Unmanned Systems Initiative (MUSI).

Dynamic Messenger 23 brought together more than 2,000 civilian and military personnel--both ashore and at sea--from 14 NATO Allies, including the host nation Portugal, plus partner nation Sweden. The exercise is conducted under the joint leadership of NATO's Allied Command Transformation in Norfolk, Va., and NATO's Allied Maritime Command MARCOM in Northwood, UK.

REPMUS has been conducted since 2019, while Dynamic Messenger is in its second year. Both are conducted at the Navy Operational Experimentation Centre in Tróia, one of two Portuguese Defense innovation centers under the NATO "Defence Innovation Accelerator for the North Atlantic" (DIANA).

The two events helped improve the ability of autonomous underwater vehicles to operate together and be integrated into task group and task force operations, as well as address personnel, training and readiness issues.

Allied Command Transformation and Allied Maritime Command executed "several operational experiments to explore and implement its multi-domain operations concept and derive observations, analysis, and lessons learned that can feed the development of the Alliance's tactics, techniques, and procedures in the use of maritime unmanned systems," according to a NATO statement. "Warfare areas that will employ maritime unmanned systems in experiments include the protection of undersea infrastructure, naval mine warfare, maritime security operations, force protection, underwater warfare, amphibious operations, and medical and logistical operations."

According to NATO, "both REPMUS 23 and Dynamic Messenger 23 have developed significant partnerships between the private sector and academia, and provide guidance for technology advancements, operational concepts, doctrine, and future work programs."

"Alongside a commitment to digital transformation, Dynamic Messenger 2023 contributes to NATO's efforts to become a Multi-Domain Operations-enabled Alliance. The exercise is a venue which allows for consultation and collaboration with

The REPMUS Exercise 2023 took place between September 11-29, 2023 at the Portuguese Navy's Operational Experimentation Center in Tróia and Sesimbra Navy facilities. The NATO Maritime Geospatial, Meteorological and Oceanographic Centre of Excellence directly supports the Portuguese Navy during this exercise, playing a leadership role in the coordination of the Rapid Environmental Assessment and leading the Rapid Environmental Assessment Working Group on partner equipment and sensors.

industry and academia and, this year, provides Allied Command Transformation an opportunity to introduce our new Operational Experimentation Emerging Disruptive Technologies Task Force," said Supreme Allied Commander Transformation, General Philippe Lavigne.

Concurrent to Dynamic Messenger 2023, Allied Command Transformation will be working towards establishing the initial operating capability of the Operational Experimentation Emerging Disruptive Technologies Task Force in late autumn 2023. According to a NATO statement, the REPMUS and Dynamic Messenger exercises and experimentation present an opportunity to explore technologies to advance the Autonomy Implementation Plan developed by the task force to identify technology options for further experimentation in 2024. Additionally, the Task Force team will be refining objectives and evaluation criteria for future events focused on Intelligence, Surveillance and Reconnaissance (ISR) and situational awareness within the maritime domain.

At the July Vilnius Summit, NATO leaders stated that while the "protection of Critical Undersea Infrastructures on Allies' territory remains a national responsibility […] NATO stands ready to support Allies if and when requested." For that reason, this year's Dynamic Messenger included experimentation on "emerging disruptive technologies" to address the threats to critical undersea infrastructure.

The Centre for Maritime Research and Experimentation is also participating in scenarios that demonstrate interoperability of C4 (command, control, communications and computers) for unmanned systems. These experiments test system of systems autonomy between the CMRE and partner autonomous systems, using the Collaborative Autonomy Tasking Layer for mine countermeasure and critical underwater infrastructure protection missions.

To gain valuable on-site feedback for exercise participants, the NATO Maritime Geospatial, Meteorological and Oceanographic Centre of Excellence in Lisbon directly supported the Portuguese Navy and exercise participants in the coordination of the rapid environmental assessment and leading the Rapid Environmental Assessment Working Group on partner equipment and sensors.

BALTOPS

Earlier in the year, Baltic Operations (BALTOPS) 23, held near Putlos, Germany, provided an opportunity for the U.S. Sixth Fleet and allied and partner nations to showcase unmanned systems capabilities.

Partnering with the U.S. Naval research enterprise, BALTOPS allowed Sailors and Marines to use unmanned underwater vehicles (UUVs), unmanned aerial vehicles (UAVs), and unmanned surface vehicles (USVs). Unmanned systems are a force multiplier, reduce operational risk in high threat areas and provide strategic advantage.

"The BALTOPS exercise series is a great opportunity to experiment," said Anthony Constable, an Office of Naval Research science advisor to U.S. Sixth Fleet. "BALTOPS is well-supported by Allies and partners, and because the exercise has such a strong history, it gives us ample opportunity to collect operator feedback on how they can best utilize the systems. Additionally, it allows us to showcase new technology to our NATO partners for future collaboration."

Arctic Fjord - full Kongsberg Discovery package for more efficient location, inspection and engagement with Alaskan pollock.

Ludeman Photographic-Sammamish

THE FUTURE OF FISHING: ARCTIC STORM

The first US-built trawler-processor for Alaskan pollock in over three decades is now undergoing sea trials in the Northern Pacific, testing an integrated technology package from Kongsberg Discovery tailored to locate, inspect and engage fish efficiently. The 100m long Arctic Fjord, designed by Kongsberg Maritime and built by Louisiana's Thoma-Sea Marine Constructor, will commence full-time operations for 2024's pollock A season in the Bering Sea.

Kongsberg Discovery said that the vessel, which replaces Arctic Storm's original, 1974-built Arctic Fjord vessel, is outfitted with systems designed to optimize both efficiency and environmental performance.

This includes: the SN90 multibeam sonar, which pinpoints schools of, and individual, fish; the ES80 sounder system, capable of detailed fish inspections; and the FX80 live camera and DFS75 gear monitoring systems, showing how nets are deployed and verifying the catch in real-time.

It's a combination, says Jess Woodruff, Kongsberg Discovery's Director, Marine Life Technology USA, that supports and consolidates the vessel's greatest strength – its extreme efficiency.

"The Arctic Fjord sets a new benchmark for the Alaskan pollock fleet," Woodruff said. "From its fuel-efficient design to the outstanding crew accommodation and state-of-the-art onboard processing facilities, every element has been cherry picked to not just do the job, but to do it to the highest possible standards.

"In keeping with that spirit, Arctic Storm challenged us with delivering an integrated package that would allow the crew to maximize catch efficiency – reducing both time on the water and vessel emissions – while working seamlessly within the ship's wider operational and processing parameters to optimize profitability. The result is a next generation trawler-processor that will deliver excellent catches, outstanding environmental performance, and a strong return on investment for this forward-thinking shipowner."

Kongsberg Discovery has a long track record with Arctic Storm, supplying sonars, sounders and trawl systems across the company's hardworking fleet.

The technology has found firm favor with crews, in a fishery driven by bycatch reduction, while still executing one of the largest wild-caught fisheries in the world. The ES80 sounder system in particular excels in this respect, with a broad frequency spectrum (from 38 to 200 kHz) allowing for detailed analysis of individual fish and schools, helping identify both fish type and size.

Raising the Bar

"It is our ambition to raise the bar with our newbuilds, providing vessels that deliver optimal results for our stakeholders, while minimizing their impacts on the environments where they operate. Efficiency is a central to achieving those objectives, and Kongsberg Discovery's advanced solutions help us pinpoint, identify and engage with our targets in a manner that is truly industry leading. We see this as the future of sustainable fishing today, and we're delighted to continue our partnership with their team onboard the new Arctic Fjord."

Once operational, Arctic Fjord will, in addition to producing pollock fillets, process fish meal and fish oil, opening up valu-

Brett Johnson,
VP, Arctic Storm

"In keeping with that spirit, Arctic Storm challenged us with delivering an integrated package that would allow the crew to maximize catch efficiency – reducing both time on the water and vessel emissions – while working seamlessly within the ship's wider operational and processing parameters to optimize profitability."

Jess Woodruff,
Kongsberg Discovery's Director, Marine Life Technology USA

able new revenue streams for the Seattle-based fishing business.

Design by Kongsberg Maritime

The Arctic Fjord is a Kongsberg Maritime NVC 336 WP trawler design. The vessel measures 99 x 21 meters and was Kongsberg's first ever contract for a US built vessel. It is one of the largest fishing vessels designed by the company.

The vessel was built, in line with the Jones Act, at the Thoma-Sea yard in Louisiana. Key design features include a wave piercing bow, which reduces fuel consumption and reduces slamming in rough seas. It has a crew capacity of 152, which means 48 cabins are incorporated into the design – much more than typical Norwegian fillet trawlers.

Designed for trawling, the Arctic Fjord has high bollard pull of 110 tons, enabled by a single Bergen 7,200kW main engine and a Kongsberg Maritime Promas Innoduct propeller of 4200mm diameter. The vessel also features a Kongsberg tunnel thruster to aid maneuverability, and a range of Kongsberg deck machinery.

Images courtesy Deep Trekker

ENHANCING SEAFLOOR MAPPING AND 3D MODELING: THE ROLE OF ROVS IN PHOTOGRAMMETRY PROJECTS

Beneath the ocean's surface, a technological revolution is reshaping seafloor mapping and 3D modeling, driven by the innovative capabilities of remotely operated vehicles (ROVs). In sectors ranging from military and government to public safety, ocean science, and offshore energy, ROVs are at the forefront, unlocking unprecedented efficiency, accessibility, and reliability.

Empowering Efficient Data Collection

Imaging technologies for 2D and 3D modeling are increasingly common in seafloor mapping and critical infrastructure management. In many cases, remotely operated vehicles (ROVs) are the sole means to reliably capture data for modeling in underwater environments.

ROVs serve as valuable tools for data collection, observation, and monitoring in underwater environments, significantly enhancing the accuracy and reliability of modeling processes. They improve the quality and quantity of data available for modeling, fostering better understanding, analysis, and management of underwater environments and structures.

Different imaging sensors on ROVs, including monocular and stereo cameras, sonar, and laser scanners, capture photogrammetry data, enabling the creation of detailed digital twins and highly accurate maps in both 2D and 3D, even in turbid water conditions.

Case Study: Stantec Using ROVs for 3D Archaeological Modeling

■ Mission Objective

Stantec Markham's archaeological department evaluated a dam structure in Nassau Mills, Peterborough, Ontario. The site housed an active dam approaching the end of its lifespan and historical remains of a previous dam from the 1800s. The survey aimed to examine the historical remains and identify construction methods for new building plans.

- **Equipment Used**

Deep Trekker's REVOLUTION and PIVOT ROVs were used in conjunction to provide extended battery life to last through the whole workday. Equipped with six thrusters, rotating camera heads, and tool platforms, they facilitated lateral and vertical movements without adjusting pitch.

- **Phase 1: Imaging**

Facing challenges like Canadian winter conditions and dam-related risks, Stantec used ROVs to conduct a quicker underwater survey than traditional methods. The team captured extensive photo coverage by field-swapping between two vehicles in a grid pattern.

- **Phase 2: Modeling**

After capturing the necessary imagery, the team uploaded findings to generate photogrammetric models using photogrammetry software. Interactive models with millimetric accuracy were created, allowing comparisons against historical documents to track environmental impacts over time.

Key Takeaways

Using Deep Trekker ROVs, Stantec quickly, safely, and easily captured all modeling photos in a single day. ROVs empowered archaeologists to direct vehicles precisely, avoiding the need for extensive communication with a dive team. The result: high-detail 3D photogrammetric models of Nassau Mills dam without risks or repeating costs.

Elevate Underwater Ops with Deep Trekker ROVs

In the dynamic realm of seafloor mapping and 3D modeling, Deep Trekker ROVs stand as indispensable tools, transforming the way professionals navigate and explore underwater environments. From military and government applications to public safety, ocean science, and offshore industries, this technology provides unparalleled precision and efficiency. Elevate your operations with Deep Trekker ROVs - a steadfast ally in the quest for comprehensive underwater intelligence.

Synchro: Helping to Pull Emerging Tech through the "Valley of Death"

Taking subsea technology from the workbench to commercialization has always been fraught with hurdles and sinkholes. Synchro is a new co-designed testbed to synchronize and evolve tech solutions. **Henry Ruhl**, Director, and **Amy West**, Program Manager of **Synchro** discuss with the possibilities for technology developers. – **By Greg Trauthwein**

As anyone in the subsea sector can attest, new tech can have its growth trajectory stunted or killed by lack of facilities, funding [or both]. Enter Synchro, which is a co-design lab to synchronize the evolution of technology for industry, aiming to accelerate the development, adoption and market use of emerging technologies in the subsea space. "The facets that we're particularly focused on are for sustainably managing ocean resources and access to those resources … that marine protected area fisheries use, ocean resource use lens is our main focus," said Henry Ruhl, Director, Syncrho. "The way that we work the mission [is] to use co-design principles. We do designs on how we're going to test and deploy things and evaluate them in the ocean, doing that in a way that helps users of information and scientists."

Ruhl's long-running day job has been as the director of the Central Northern California Ocean Observing System, which is part of the U.S. Integrated Ocean Observing System (IOOS), which is part of the Global Ocean Observing System (GOOS), meaning he is particularly well situated as the Director of Synchro given his front row seat to the development and use of technologies in the ocean.

"We help deliver the mission of the National Ocean Service, providing ocean information for decision making every day, and ocean management for things like national marine sanctuaries, fisheries, marine protected areas, shipping, search and rescue." Ultimately, his work is primarily in facing challenges with technology, access to technology to meet the demands of information users.

That challenge – to accurately, persistently observe, measure and document the biology of the ocean, led in part to the creation of Synchro. "There's this need for bringing technology into the broader use and doing that in a way that meets the needs of end users in a way that the end users understand what they're getting, they trust this information and are willing to use it in documentation and decision making."

Getting that technology from the test bed to the market … dragging it through the "valley of death that many of us in the ocean technology space are familiar" is a core tenant of Synchro. "Ultimately, in some years' time, we'll have access to some of the really promising technologies that are out there, but are still not broadly available or trusted."

The 'synchronizing' part of the program importantly includes "involving those resource managers and decision makers from the beginning with the testing," said Amy West, Program Manager. "So ideally there's an increase adoption of all of this; that's our synchronizing part."

Synchro Today

Synchro today is on a four-year program, a program built on "three pillars that stand-up our work that all use this co-design principle," said Ruhl.

1. The first is access for new and emerging technologies to testing and evaluation, open to anyone globally. The tech can be a prototype or even something more advanced, but not in broad use. "They can apply for access here in the Monterey Bay area and also in British Columbia to a series of access points, meaning shore stations, buoys, test tank facilities, pressure test facilities, pump houses, etc," said Ruhl.

2. The second is low cost technology procurement and evaluation. "We're going to spend a sizable amount of money on procuring and perhaps leasing new and emerging technology that fits this low cost description at low-cost tech," said Ruhl.

3. The third is a case study for understanding how to monitor offshore wind industry impacts. "Everybody can see that the offshore wind industry is starting to grow here in California; this is happening," said Ruhl. How do we build this industry, an industry that's moving into deeper water, operating in areas where there haven't been industry operations before? How do we do that with providing information for maintaining resources such as fisheries and managing protected species.

The Subsea Tech Fast Track

Synchro is funded through the Gordon and Betty Moore Foundation, Oceankind and the Schmidt Marine Technology Partners. It's a four-year program, and the cost for applicants to access the testing and evaluation facilities is free. "What that can get you is access to a physical station where you can connect sensors to a network, for example on a buoy or at a shore station, or perhaps if it's a little bit earlier stage in a test tank or in a pressure test facility," said Ruhl. Successful applicants will also have access to technicians and technical support working in collaboration with applicants and developers to get their technology integrated so that it can be evaluated.

It's about helping companies and technologists navigate the aforementioned long-running challenge of emerging from the 'valley of death', moving promising technology from its infancy and adolescence to full maturity, where perhaps it can be deployed to help solve some of the more pressing challenges for scientists, legislators and corporations globally. "The [subsea] community has faced this problem for many years," said Ruhl. "There are other initiatives, but what we wanted to do is make that [process] a faster and more accessible. Instead of having to write a big proposal to NOAA, we can take an application and make as easy as possible."

Ruhl stresses time and again the collaborative aspects of Synchro, as the communication and technology flow is not a one-way street. "The application is really about starting a conversation with us; what you'd like to achieve, and does it match with what we can accommodate in terms of testing facilities and expertise."

So Synchro comes to the table not only with technical experts on the physical piece of equipment, but also scientists who work on the intellectual concepts, insights that might help to broaden the potential scope and use cases for a given technology to help fill broader ocean intelligence gathering gaps.

"Technologists are not always connected to their users and engineers and are not always marketers," said West. "I think the valuable part of Synchro is that we're working on that product market fit, so someone is not working in a silo and that prototype stays a prototype."

Watch Marine Technology TV's full video interview with Synchro's Henry Ruhl and Amy West here:

MARINE TECHNOLOGY TV

Or visit:
oceansynchro.io

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Greensea IQ Expands

The Greensea IQ Team

EverClean Hull Cleaning Robot

Images courtesy Greensea IQ

On October 17, 2023, the waterfront in Plymouth, MA, was abuzz with innovation and excitement. A demonstration and ribbon-cutting event hosted by Greensea IQ in Cordage Park showcased some remarkable technology by Bayonet, a Greensea IQ company. Other manufacturers, including SeaTrac, Jaia Tech, and MIT SeaGrant, were also on hand to demonstrate their technology.

The new Greensea IQ facility is an expansion that establishes a manufacturing center for the production of several navigation and robotics systems including the Bayonet line of surf zone crawlers, EverClean hull cleaning robots, RNAV3 diver

"This expansion is the next step in Greensea IQ's transition from doing custom development work to delivering fully integrated intelligent products for working in the ocean," said **Rob Howard**, Chief Growth Officer, Greensea IQ. "The new facility will support the planned growth and worldwide expansion of our robotics-as-a-service program, EverClean, while it gains adoption as fleet owners work to meet increasingly demanding carbon emissions requirements and increased hull performance throughout the cruise and shipping industries. Plymouth will also allow us to quickly scale to meet demand for the new Bayonet line of AUGVs as we start d-livering the platform to defense and commercial customers for use in near shore MCM, EOD, UXO and surf zone survey applications."

Cordage Park is on Plymouth's picturesque waterfront, providing a perfect backdrop for this innovative demonstration event.

Bayonet specializes in Autonomous Underwater Ground Vehicles (AUGVs), offering a range of sizes to meet diverse mission requirements. The Bayonet AUGVs are renowned for their adaptability, precision, and durability, which makes them ideal for various aquatic environments. This demonstration event was more than just a showcase of technology; it was a crucial part of the Blue Future Conference. Organized by the Plymouth MA Economic Development group, the conference is part of a visionary initiative to build a sustainable industry in Plymouth. It aligns perfectly with the town's rich maritime history, ensuring that the legacy of innovation continues to thrive in the region. The event presents a proactive step toward fostering economic growth while maintaining environmental sustainability.

Attendees had the opportunity to watch the demonstrations of cutting-edge technologies at the waterfront before attending a ribbon-cutting ceremony and reception. This ceremony marked the inauguration of Greensea IQ's new Integrated Systems Production Facility, a state-of-the-art center dedicated to developing and assembling advanced marine technology. A reception followed the ribbon-cutting ceremony with local dignitaries, friends of Greensea, and maritime professionals from South New England in attendance. ***– by Rhonda Moniz***

New EverClean Robot

Greensea IQ launched of its most advanced EverClean service robot, a leap forward in the realm of supervised reliable autonomy with Over the Horizon (OTH) operational capability for underwater hull maintenance.

The EverClean robot is packed with features like depth aided navigation, smarter obstacle avoidance, improved maneuvering and enhanced user interaction capabilities; all budled to provide even more precise hull relative navigation than before, a key evolution in making the robots faster and more efficient in cleaning ships. The EverClean robots can autonomously cover areas up to 50 square meters on a ship's hull.

In addition, the new unit has also had significant improvements in the robot itself, starting by an increase in the brush deck size. The EverClean robots will be able to double its production rate over that of the first EverClean robots, meaning any given area can be cleaned twice as fast in half the 'stick time' (duration of operator supervision), optimizing cleaning efficiency and reducing operational drag. The EverClean robots also benefit from enhanced thrusters, markedly elevating responsiveness and control. These thrusters have been proven to bolster the service robots' stability, agility, and adaptability in dynamic conditions, and have also been engineered for more efficient power use and optimized distribution within the system. This means that the robots can do more with fewer amps of power, both significantly prolonging cleaning times on hull, while reducing recharging frequency.

GENERATIONS OF INNOVATION IN SONAR & ULTRASONIC TECHNOLOGY

Massa Products Corporation designs and manufactures sonar and ultrasonic products for use in ocean, air and fluids. A long-tenured innovator in the subsea space, Massa is the "eyes and ears for navy ships and submarines," boasting more than 170 U.S. Patents awarded. While Massa serves the defense, commercial and scientific communities, **Dawn Massa Stancavish**, President, CEO & Chief Innovation Officer, discussed with ***Marine Technology Reporter*** how the prevalence of geo-political conflicts is driving its innovation for its defense customers, as well as the keys to attracting and retaining the engineering talent that will drive Massa for the next generation.

By Greg Trauthwein

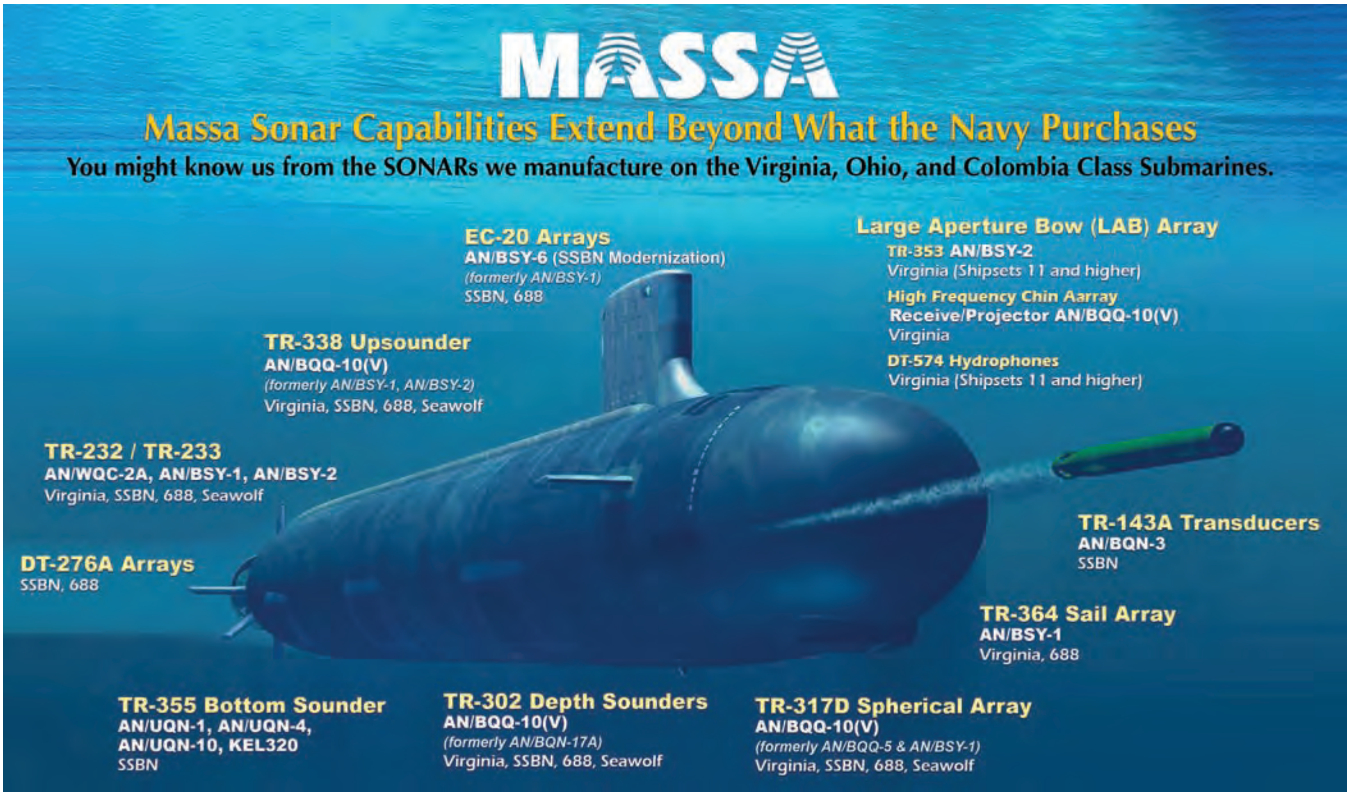
Photo courtesy Massa

[An option for a young person who] wants to do something meaningful, to with their hands and their mind, to build and create new products, to build pieces for submarines, they need to understand that they could do that here.

Dawn Massa Stancavish

President, CEO & CIO, Massa Products Corporation

Photo courtesy Massa



I know your business is driven by multiple markets – defense, offshore energy and science –but let's start on the defense business as it's most topical given the various geopolitical conflicts.

Absolutely. The Navy has publicly announced an increase in our build of submarines, and the trajectory and goal is to make one Virginia- and two Columbia-class submarines a year. Today has both similarities and differences from the WWII era. The parallel is that prior to World War II, we had the Great Depression and we also had other conflicts in the world; the war started in Germany and in Asia before it reached America. Our allies were asking for help, and we were sending supplies to help them.

We were in a similar spot from the sense in that we had been hurt economically by the depression; [most recently] we were hurt by COVID. Today you see conflict in Ukraine, you see conflict in the Gaza Strip, as well as other places, and we're sending aid. It's eerily similar to where we were, but in a completely different way.

A key difference: America was very much a manufacturing nation in the late 1930s and early 1940s. We were the leader in manufacturing in many respects. Today, we've shipped a lot of our manufacturing overseas, and we've heard our president talk about how we have to bring manufacturing back.

Even though we're small, Massa feels that we're an important fixture in this effort because we've maintained our footing with our technology as a leader in what we do for the Navy. We've also maintained that in industry, but we've also maintained the ability to have control over our manufacturing process, continue to grow that process and have quality products throughout.

A big part of that equation is technology, but an equally big part is workforce. Everyone's looking for qualified people. What is Massa doing to solidify its workforce of the future?

The Navy wants to build up the workforce, build up manufacturing. The president wants to build up manufacturing across the board, but specifically through the submarine industrial base to meet the challenge and the requirement to build the one plus two. And Massa is a submarine supplier.

We have an interesting demographic. We're located on the south shore of Massachusetts, and we have a community here where there are a lot of wealthy families, but there's also families that aren't so wealthy. Kids look at going into college, and see that the pricing has increased dramatically. So there are some kids that are technically inclined, that might have had hopes of becoming an engineer, but realize [the cost and resulting debt may put it out of reach].

[An option for a young person who] wants to do something meaningful, to with their hands and their mind, to build and create new products, to build pieces for submarines, they need to understand that they could do that here.

I'm spreading that news everywhere; we're hiring different types of jobs, everything from machining to assemblers to engineers. We have so many different types of technical possibilities for people to come and have a career that's also contributing to our national security end goal, plus some cool projects in the commercial and oceanographic side.

There's a company called Blue Forge Alliance that's sponsored this amazing ad campaign called buildsubmarines.com. It's a website, but they have commercials and billboards that talk about building giants, which refers to the submarines and how more people could have a career [in the business]. We're really happy to be a part of that effort.

Another leg of your business is offshore energy, both traditional oil and gas and as well as the emerging offshore wind. When you look at offshore wind, what opportunities do you see for Massa?

What I see with wind are where there are the problems, we might be able to help. I know that there's a lot of issues in that market that span into other areas, and I think that the solution is collaboration, understanding the issues. [The companies in the sector are working on] where to put things how to do it safely without hurting animals; how to know where the animals are … we have products that can assist with those things. There are other aspects of what we do in our product line that have to do with other types of energy. We have everything from level sensors to sub-bottom profilers to different types of sensing technologies that can assist and can identify different types of things in the water.

As you mentioned, mammal monitoring, both in connection to the offshore construction and shipping, has begun top of mind with legislators. And we talk more and more about the blue economy, but that blue economy means you're working more in the water, with potential impacts on wildlife and the environment. With that as a backdrop, how has this driven your business in the last year?

This one is something that's near and dear to our heart. In the early to mid-1980s, my dad was involved with a sonar grant program that he had with the University of Hawaii, a program studying the habits and migration of humpback whales. I like to joke that that was one of my first business trips, as I was a very young girl, but I got to go along for the trip and I did get to swim with the whales, which was really cool.

It was inspiring and it left a lasting impression on me. Sonar is one of those things that, over the years, has sometimes been blamed for harming animals. But it's actually the main tool for studying them, understanding where they are, hearing and recording their calls, listening to how they communicate with each other, and that study in the '80s turned out to be the very first study ever done on whales with sonar.

We've been involved since the beginning, and we're very interested in how our technology could help animals and help industry at the same time. I believe that the answer for everyone is not what divides us, but looking at how we make everything work. There's harmony in the ocean, and there's all kinds of things going on in different areas where it's too easy to say that one thing is the problem or one thing is the solution. It's never that.

You need to have partnerships with people in industry, the people who are innovating, so all can collaborate to solve problems.

I think that all of these issues with mammals, with wind – with any challenge – if you have an innovative partner, it's better to communicate to see if you could find a solution for less money and greater reliability. It's about working together to achieve goals.

Speaking from the Chief Innovation Officer part of your title, what specifically are the drivers today for the product and technology innovation inside MASSA?

The Chief Innovation Officer title I earned soon after I had joined the company. I was a part of the board of directors for the company before I actually started working here, because I my family lived out of state, and we moved back when the kids were the right age. Then I came here to work, learning all different departments from a different perspective. I was working in sales and I noticed that we were really great at selling products that we understood, but we weren't always great at connecting the knowledge of what the technology could do, with where it could go. That's when I started to ask questions, and over time, I was able to figure out new ways we could use our technology in new spaces, and it resulted in multiple patents. For example, on the ultrasonic sensing side, a lot of products have a 40 kilohertz transducer as one of their product offerings. The only reason that transducer exists came from when my grandfather was at RCA. They needed to find a frequency that worked for changing the channel on a television, and that is the origin of the 40 kilohertz transducer. [It started off as a means to change the channel, and has morphed into a staple of many product lines].

So that's the innovation side, figuring out where else things can go.

I think [this approach] is a little different than a lot of business models. A lot of business models simply look at their product line and they try to increase their revenue, they grow by acquisition, they acquire technology by acquiring companies. We don't think of it that way. We're going to do what we do well, and we're going to apply our brains to make winning products.

Your company is engaged in a large number of interesting projects. Can you discuss a recent project that you believe highlights the Massa brand?

There's a bunch of projects in the works that we're really proud of, but a lot has to do with the government, so I can't really say. On the commercial side, I'm happy with a wireless product that we're about to launch. It's not quite full stream, but it's going to have so many different types of options with it, and it's way more user-friendly than a lot of products on the market. There's another product that has the ability to work both underwater and in air that we're really excited about.

TIAMAT: SUSTAINABLE DREDGING TECHNOLOGY

All Photos Courtesy Harwich Haven Authority/Haven Dredging

Dredging globally is part science, part art, particularly given the vast differences in areas and materials to be dredged. Haven Dredging offers its patented Tiamat solution, an innovative agitation dredging solution that purports to lower maintenance dredging costs and is a cleaner process compared to traditional methods. The technology is designed to be adaptable and easy to deploy, suitable for port authorities and harbor engineers, as* Jake Storey, *Executive Director of Haven Dredging, explains.

By Greg Trauthwein

Haven Dredging, launched in April 2023, is the commercial arm and a wholly owned subsidiary of Harwich Haven Authority, a port authority in the east of England which has the largest container terminal in the UK, with big 24,000 TEU vessels calling on a regular basis.

"We have to do a lot of maintenance dredging, about 2-3 million metric cubes a year … and our disposal site is about 16 miles offshore," said Storey. "So we would historically have five or six trailer hopper dredging campaigns a year, and it would cost us about 20 to 25% of our turnover each year. It was a huge cost and we anticipated it increasing through inflation, environmental levies" among other rising costs, including the fact that the port had recently completed a major capital project, deepening the harbor and sea access from 14.5 to 16 meters. "So our level of accretion was modeled to go up by 20%, and we thought we had a major cost problem."

The cost was one, albeit big, portion of the equation, but also the port authority had to factor in the greenhouse gas emission portion of the project, considering the frequency, volume and distance offshore for disposal. "A lot of the dredging kit is old, so relatively it's a high level of pollution," said Storey.

So the challenge here, and arguably in every port authority in every country, is how it could reduce maintenance dredging costs without impacting navigation safety.

"Navigational safety is paramount, so if we need seven trailer campaigns, we have seven trailer campaigns," said Storey.

Trial & Error

In envisioning potential solutions, Storey and his team conducted a trial in the harbor using a trailer, but simply side casting the sediment from the trailer instead of going to the disposal site. "The sediment went away and we thought, 'Okay, that's good. The sediment has gone away. I don't need to dredge it, but do I need a trailer?"

Next they mocked up a design of Tiamat and took it marine engineers to make the prototype. "In March 2020, we did our first trial of a month in one part of the harbor. We documented it, in terms of surveying where the sediment went, and it was all very positive," said Storey. Next, his team conducted a more detailed study, including HR Wallingford, a UK hydrographic company organization that works globally, to document the productivity of the Tiamat system; essentially charting where the sediment went. "We did an environmental impact assessment on the back of that and got our environmental regulators alongside and approve the use of this technology," said Storey.

How does it Work?

Tiamat consists of a frame carrying one pump to inject water into the sediment overlying the bed of the harbor, and a second pump to extract diluted silt, pump it up and release it into the water column.

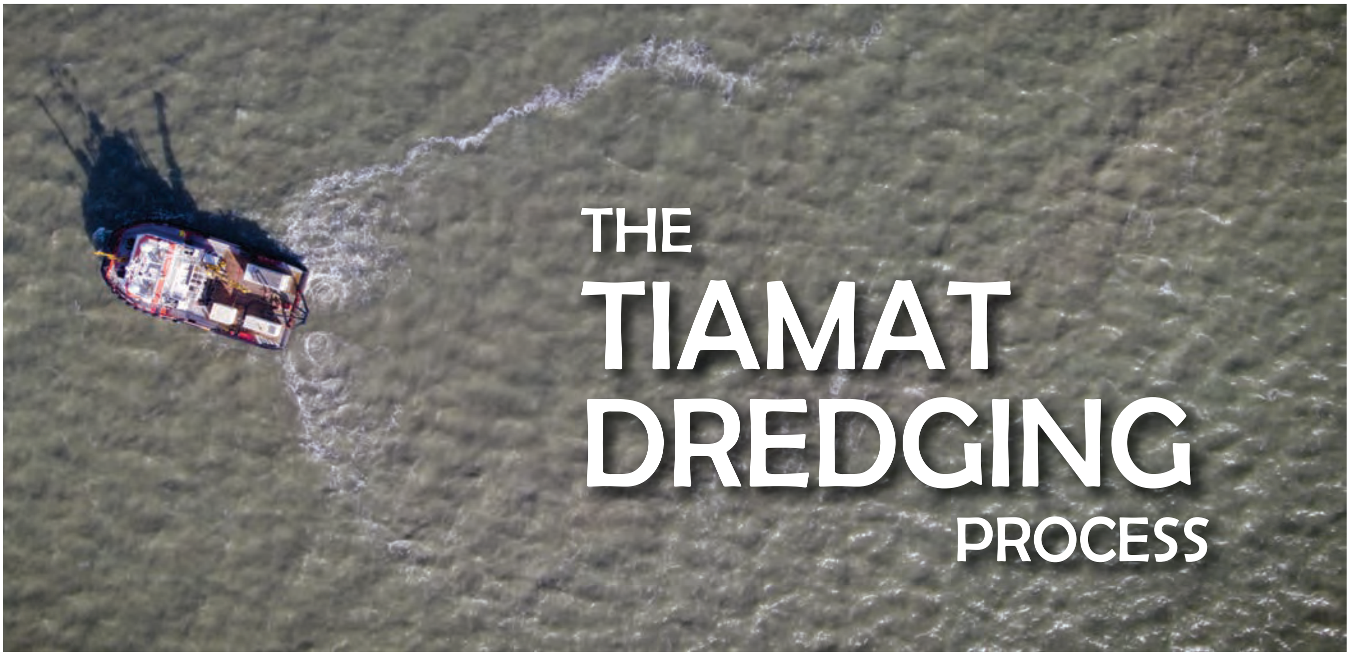
Designed to be mounted onto a small workboat or multi-cat of between 25-27m that has an A frame, Tiamat is lowered into the water to the depth required.

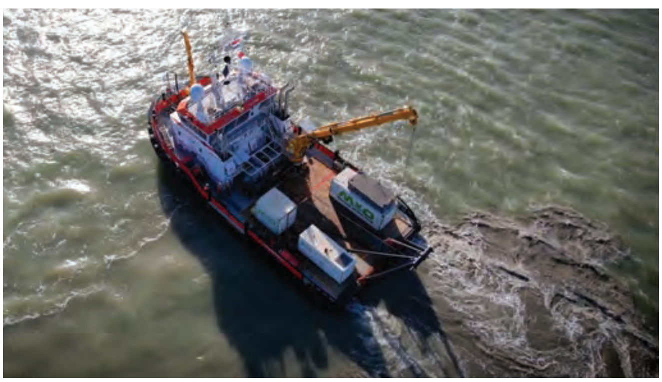
It uses the power of the tide and currents, promoting self-replenishment in the estuarian system, through the natural re-suspension of sediment – thus, "Dredging with Nature".

Because it places the sediment back into the water column at the appropriate depth, there has been no evidence of turbidity or the water quality being impacted.

The ability to use a standard small workboat resolves some

THE TIAMAT DREDGING PROCESS





Where Does Tiamat Work?

Jake Storey, Executive Director of Haven Dredging, admits that the Tiamat dredging technology is not a 'silver bullet' solution. "We see Tiamat as complimenting existing forms of dredging; it will perform better in certain locations than a water injector; it will be cheaper, and as effective or as productive as a trailer in other locations." He said Tiamat "puts energy into the system, it pumps [material] up into the water column. If you want to move sand and gravel, you won't move it a great deal of distance with a Tiamat, unless you've got huge amounts of tidal flow and super strong currents. However, if you only want to move it a couple of hundred meters then the Tiamat may work, if you want to move it out of your harbor, then the Tiamat won't be your solution." In the Harwich Haven Authority, the sediment is predominantly clay silt with a bit of sand, with a tidal range of about two to three meters and currents just under one knot. "We have parts of the harbor where the Tiamat reduces the strength of the sediment, but leaves it behind because we have eddies. In other parts of the harbor, because of the way the currents move and where the tide goes, it just takes it out of the harbor completely. If you want to move the sediment long distances, then you need a decent current tide and silt. If it's highly compacted sediment, you can't break the laws of physics. The Tiamat will have an impact on it, but you most probably need a cutter or a backhoe or a trailer."

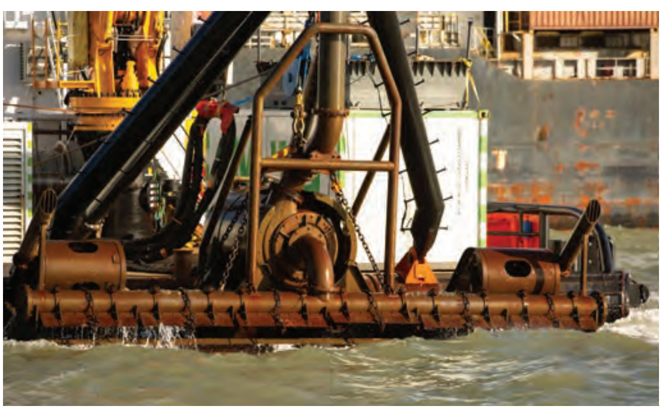
of the capacity and resource constraints that exist in the dredging market, and lowers fuel consumption compared to traditional methods. It also eliminates the travel back and forth to disposal sites, which comes with a definitive and measurable GHG emission impact.

"Also, it works best where you're going from shallower water to deeper water," said Storey, relying on gravity and the slope to help do the job.

With positive environmental impact results, the icing on the cake is the financial savings, too. "What it means going forward is that we won't need to have six trailer campaigns a year," said Storey. "We'll have two or three, and that's where the cost savings and the greenhouse gas emissions savings come. So for us, and it is site specific, on a Tiamat campaign of 30 days as compared to a trailer campaign of 10 or 12 days, our greenhouse gas emissions are 65% less. And likewise, on cost wise for us, maintenance dredging for a trailer campaign would be between £1.2 million to £1.5 million. And a Tiamat campaign is roughly between £400,000 and £500,000. So next year, we anticipate to save about £2 million or £3 million pounds just in our harbor. And for us, that's about 50% of the total cost of maintenance dredging that we're saving."

While Storey is obviously bullish on the Tiamet technology, he points out that the tech is not meant for use on any and every site, as distance to dredge disposal area, consistency of dredge material and the nature of the tidal flow and water column all come into play. "If we would have had a disposal site one mile offshore, I don't think we would've invented the Tiamat because we didn't have the business need from the greenhouse gas emissions and a cost perspective. For us, it is driven by the location of our disposal site, and the economics of it."

THE TIAMAT TECH



All Photos Courtesy Harwich Haven Authority/Haven Dredging

MARINE TECHNOLOGY REPORTER

2024 Editorial Calendar

January/February 2024
Ad close Jan.31

Underwater Vehicle Annual

- Offshore Wind: A Floating Future
- Subsea Defense
- Manipulator Arms & Tools
- Autonomous Navigation
- Battery Technology

Event Distribution:

Oceanology International,
London, UK
Subsea Expo
Aberdeen, UK
Floating Wind Solutions
Houston, TX, USA
Europe Offshore Wind
Bilbao, Spain

February 2024
Ad close Feb. 4

Digital Edition

MTR E-Magazine Edition:

Oceanographic

March/April 2024
Ad close March 21

Offshore Energy

- Oceanographic Instrumentation & Sensors
- Subsea Defense: The Hunt for UXO
- Inspection, Repair & Maintenance
- Underwater Communications
- Cables & Connectors

Event Distribution:

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UDT
London, UK
IPF Wind Conference
New Orleans, LA, USA
AUVSI Xponential
San Diego, CA, USA

May/June 2024
Ad close May 21

Dredging Technology

- Hydrographic Survey
- Scientific Deck Machinery
- Workclass ROVs
- Seismic & Geotechnical Surveys
- Sonar, Telemetry & Data Processing Software

Event Distribution:

WEDA Dredging Summit & Expo
Las Vega, NV ,USA

July/August 2024
Ad close July 21

Autonomous Vehicle Operations

- Underwater Tools & Manipulators
- GPS, Gyro Compasses & MEMS Motion Tracking
- Subsea Defense
- Deck Machinery & Cranes
- Battery Technology

Event Distribution:

Oceans 2024, Halifax
Halifax, NS, Canada

August 2024
Ad close Aug. 4

Digital Edition

MTR E-Magazine Edition:

Hydrographic

September/October 2024
Ad close Sept. 21

MTR100

Focus on 100 Leading Companies, People and Innovations in the Subsea Space

November/December 2024
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Ocean Observation: Gliders, Buoys & Sub-Surface Networks

- Instrumentation: Profilers, Samplers & Sediment Corer
- ADCPs & DVLs
- Subsea Defense: The U.S. Navy
- Subsea: Electrification
- Underwater Imaging: Lights, Cameras & Multibeam Sonar

December 2024
Ad close Dec. 4

Digital Edition

MTR E-Magazine Edition:

Subsea Vehicles

All images courtesy Curtin University

Digital 3D model of WA Shipwreck

The underwater remains of a ship built in Fremantle in 1876 and which sunk off the coast several years later can now be explored with ease thanks to a digital 3D model unveiled by Curtin University and the Western Australian Museum following the recent 143rd anniversary of its loss.

Colonial schooner the Star was used as a whaling vessel for expeditions off WA until 1880 when a dramatic maritime mishap caused it to sink off Rockingham, thankfully without loss of the crewmembers' lives.

Returning from an unsuccessful whaling trip to Geographe Bay, a navigational error saw the vessel plough into the Murray Reef near Port Kennedy at about 3am on October 20, 1880.

The wreck was discovered in 1972 at a depth of 2.7m and the WA Museum excavated the site in 1983, during which overlapping black and white film photographs were captured and a 2D photomosaic was created.

In the summer of 2022-23, Curtin University HIVE (Hub for Immersive Visualization and eResearch) Internship student Jarod Harris used the photography from 1983 to create the digital 3D model of the wreck released today.

Associate Professor Andrew Woods, manager of the Curtin HIVE said the Star was significant as an early Western Australian-built vessel, with the wreck providing evidence of colonial ship-building methods and materials.

"The digital 3D model has been created from the legacy photography using a technique known as photogrammetric 3D reconstruction," Professor Woods said.

"The new 3D model of the Star allows the wreck site to be inspected in much greater detail than ever before, including with use of visualization technologies such as virtual reality.

"By visiting the website, the wreck model can be panned, rotated and zoomed in on as a 3D object, and examined from any angle."

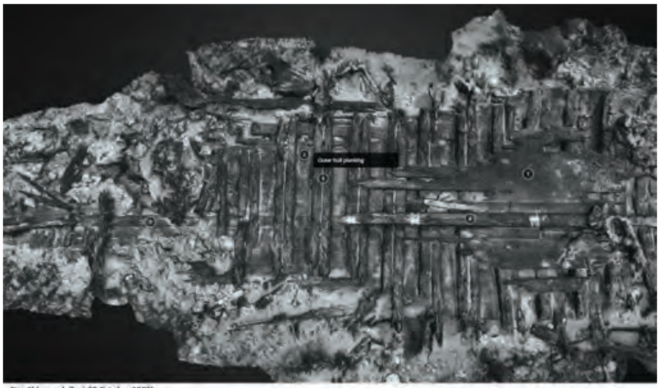
Dr. Ross Anderson, Curator at the WA Museum said the latest inspection of the wreck site in 2004 revealed very little of the vessel remained after decades of exposure to the underwater elements but in 1983 parts of the wreck were in good enough condition to be identified as being made from jarrah, sapwood, red mahogany and red gum, sourced from both WA and interstate.

"No whaling equipment was found at the wreck site, but large pulleys were recovered, along with artefacts including a brass ship's log, a penny dated 1876 and different types of ceramic wares," Dr. Anderson said.

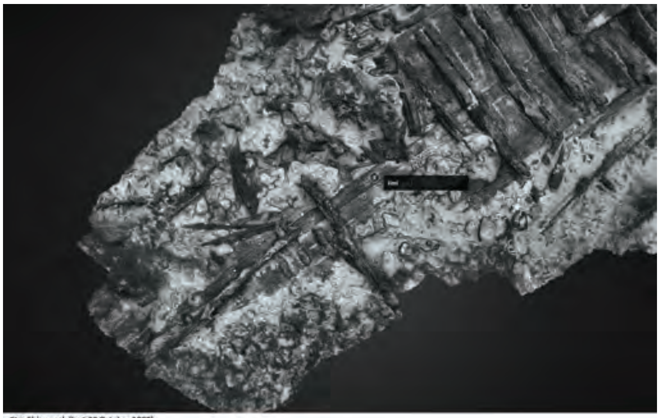
Mr Harris said being able to create the 3D model from the WA Museum's records of an archaeological excavation conducted 40 years ago was an exciting and very satisfying process and captured a moment in time.

"Our 3D model gives researchers and the public virtual access to this significant archaeological site and enables them to learn more about Western Australia's early maritime history," Mr Harris said.

Star Shipwreck (lost 20 October 1880)



Star Shipwreck (lost 20 October 1880)



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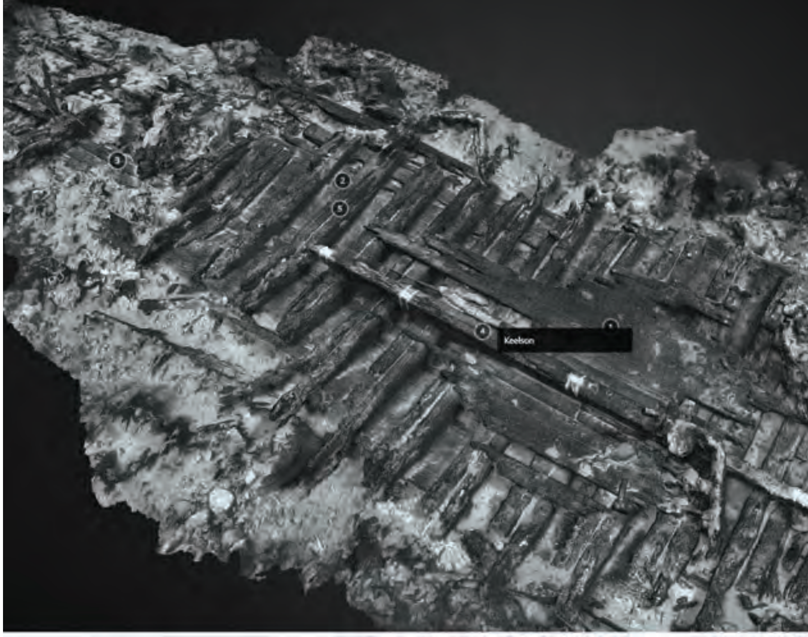
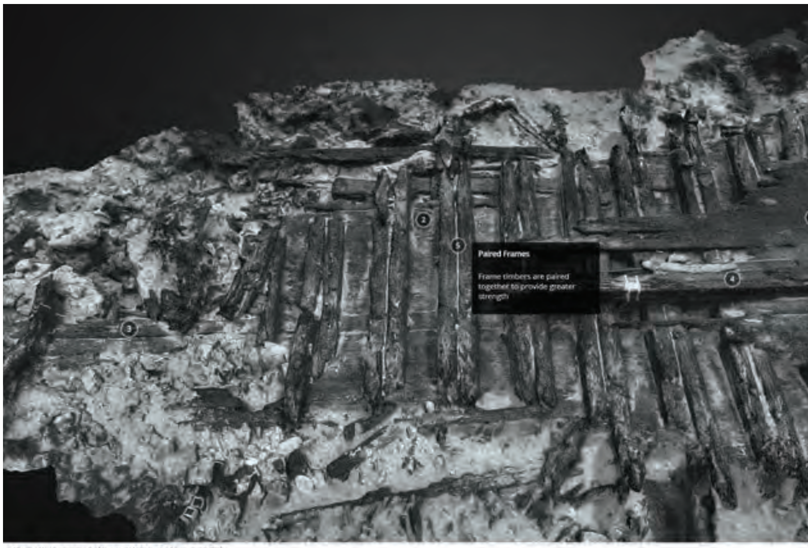


Star Shipwreck (lost 20 October 1880)



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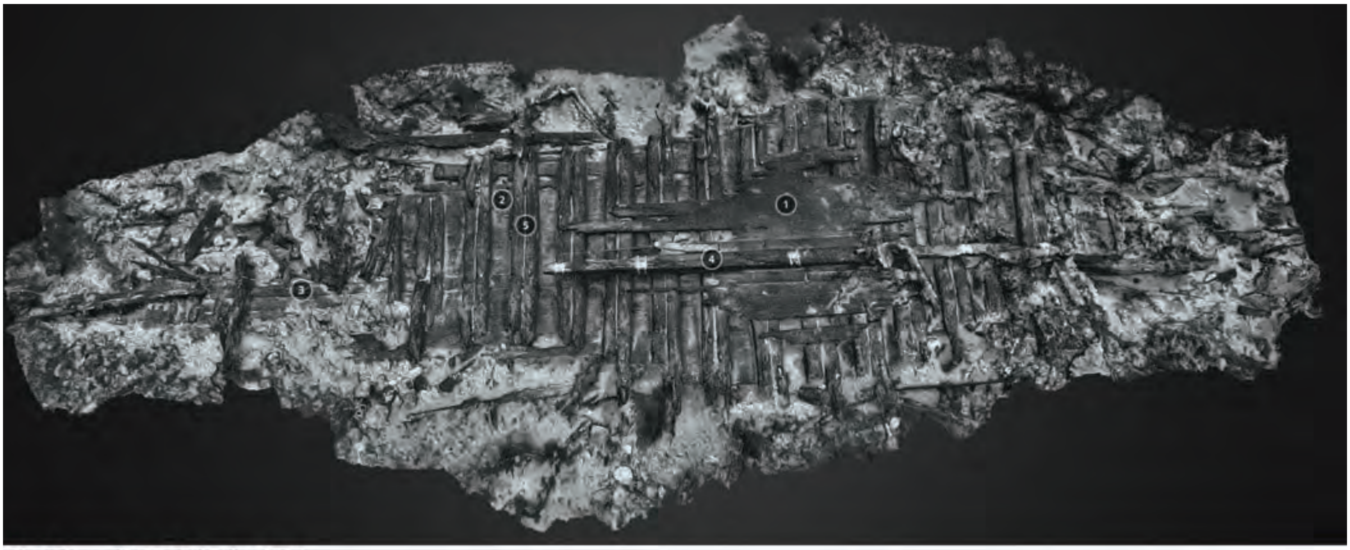


Star Shipwreck (lost 20 October 1880)

All image courtesy Nortek

Tethys Robotic's new ROV Leverages Nortek DVL Tech

Tethys Robotics' underwater drone in Lake Zurich during a harbor inspection.

A new Remotely Operated Vehicle (ROV) from Switzerland's Tethys Robotics is using a Nortek DVL to complete its navigation solution. Jonas Wüst, CEO at Tethys Robotics, set out to meet these challenges of working efficiently, safely underwater following a student research project at Eidgenössische Technische Hochschule Zürich (ETH Zurich), a public university in Switzerland.

Tethys Robotics' goal was to build an autonomous underwater robot capable of being deployed in rough water with currents of up to 2 m/s. It would need to be capable of high-accuracy positioning and inspection of its immediate environment in near-zero visibility. This required a very accurate underwater navigation solution.

Control in Swirling Currents

If this can be achieved it provides immense advantages to operators, as they can focus on controlling the robot relative to the stationary physical surroundings, without having to worry about trying to control it against swirling currents.

To meet these positioning and navigation needs for their ROV, Wüst and his team equipped their small ROV with a Nortek DVL that meets their specific requirements for achieving bottom tracking and current measurements in the most difficult conditions, securing navigational accuracy.

The DVL, or Doppler Velocity Log, is an acoustic sensor that estimates velocity in water relative to the bottom, using a long pulse along a minimum of three acoustic beams, each pointing in a different direction.

Bottom Tracking Near a Moving Riverbed or Sea Floor

During Tethys Robotics' first discussions with Nortek, the DVL500 Compact had just been released. This is a 500 kHz DVL in a small form factor – a good match for the requirements of the small ROV the team at Tethys Robotics was working on.

By combining the convenient size of the higher-frequency DVL1000 with the superior bottom-tracking range of traditionally larger 500 kHz systems, the DVL500 Compact provides developers of small robotic systems with a reliable, high-performance solution for aiding underwater navigation and control.

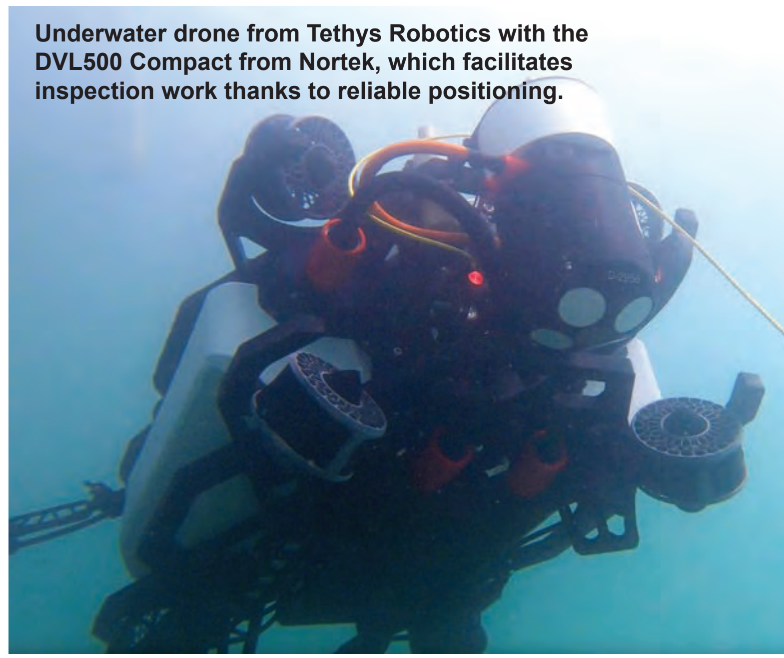
"The benefit of the DVL500 Compact for Tethys Robotics was the good penetration of the DVL's signals through the bottom, river or lakebed," said Nortek's Cristobal Molina, the Senior Sales Engineer working on the project.

Autonomous Mapping in Strong Currents and Poor Visibility

Their work with the underwater robot has attracted a lot of attention. "Tethys Robotics is an invaluable partner for developing underwater robots with unique capabilities, such as for autonomous mapping of submerged infrastructures in strong currents and poor visibility," said Kai Holtmann, Deputy Head of the

Jonas Wüst, now CEO at Tethys Robotics, set out to build an autonomous underwater drone following a student research project at Eidgenössische Technische Hochschule Zürich (ETH Zurich), a public university in Switzerland.

Professional divers and the Tethys ROV after an underwater inspection operation.



Underwater drone from Tethys Robotics with the DVL500 Compact from Nortek, which facilitates inspection work thanks to reliable positioning.

Swiss Drone and Robotics Center. “Their innovative approach allows inspection and exploration works to be carried out at lower cost and, most importantly, without putting divers at risk.”

The success of the unit has opened up a whole new world of applications.

“We are now aiming for applications where we can replace divers, especially in dangerous situations. We recently had our first test with a hydroelectric plant, where the underwater robot had to hold its position relative to the ground in a river flowing at up to 1.2 m/s. It was quite a milestone to see it used in this application, and how easy it is to do inspections if you have good localization and mapping,” Wüst says.

The technology promises significant benefits for the reliability and safety of important infrastructure.

“Wherever you have submerged infrastructure, good reliable inspection is key.” There are also promising applications for research on submerged structures. “We’re in talks with archeological teams here in Switzerland,” Wüst said.

The Tethys ROV can be used from land or from boats without any further deployment equipment.

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