TERRADEPTH

Terradepth is shortly to begin full sea trials of its new ocean data collection concept. The aim is to create a comprehensive and highly accurate virtual ocean model to allow humans to make better, faster decisions with respect to the underwater sector at large. This could help predict atmospheric weather patterns, build underwater energy and telecom infrastructures, and protect and ensure our coastal communities' future.

“We have decided that the best way we could make the most impact is to concentrate on two main components,” said Joe Wolfel, Co-CEO at Terradepth.

“The first is to scale ocean data collection and the second, to radically improve the user experience with that scaled ocean data in a similar way that the user interacts with Google Earth or Google Maps.

"In terms of accumulating ocean data collection, we considered that currently, perhaps the major limiting factor, especially when accumulating deep ocean high-resolution data, was the requirement for human support of the underwater robotic asset.

“The obvious answer was to replicate the functionality that humans provide to the underwater asset. At present, this typically is based on using a crewed ship, which provides two vital services—a precise geolocation reference to the asset and a recharge capability which typically equates to swapping out batteries after or within the operation.

"The vessel also provides a data transfer system. It can access the data from the underwater vehicle, process it and transmit it. We quickly recognised that we needed to do these three things fully autonomously.

“We consulted a number of AUV vendors and eventually settled on a baseline robotics platform provided by Cellula. The solution we selected was a SOLUS vehicle.

One aspect of the SOLUS design is its ability to stay at sea for a considerable length of time due

Terradepth's AUV

in part to its innovative fuel cell technology. We decided, however, at least for the time being, this was not a feature that we required to address our objectives. We opted, therefore, for a new version called the Solus Lite, in which the fuel cell is replaced by a more conventional source due to our intent to address customer needs more rapidly."

The Terradepth vehicle system is referred to as an AxV. In operation, the company plans to employ two (or more) identical vehicles, one operating semi-submerged and the other operating at depth.

During at-sea operations, the topside AxV provides sea surface data collection, communications and navigation assistance while the submerged AxV conducts its submerged mission. The two AxVs can then switch roles once the submerged vehicle’s energy is expended to a predetermined level.

Once surfaced, the vehicle employs a hybrid system of rechargeable lithium batteries and an air-dependent power plant capable of operating high-power, high-logistics instrument payloads.

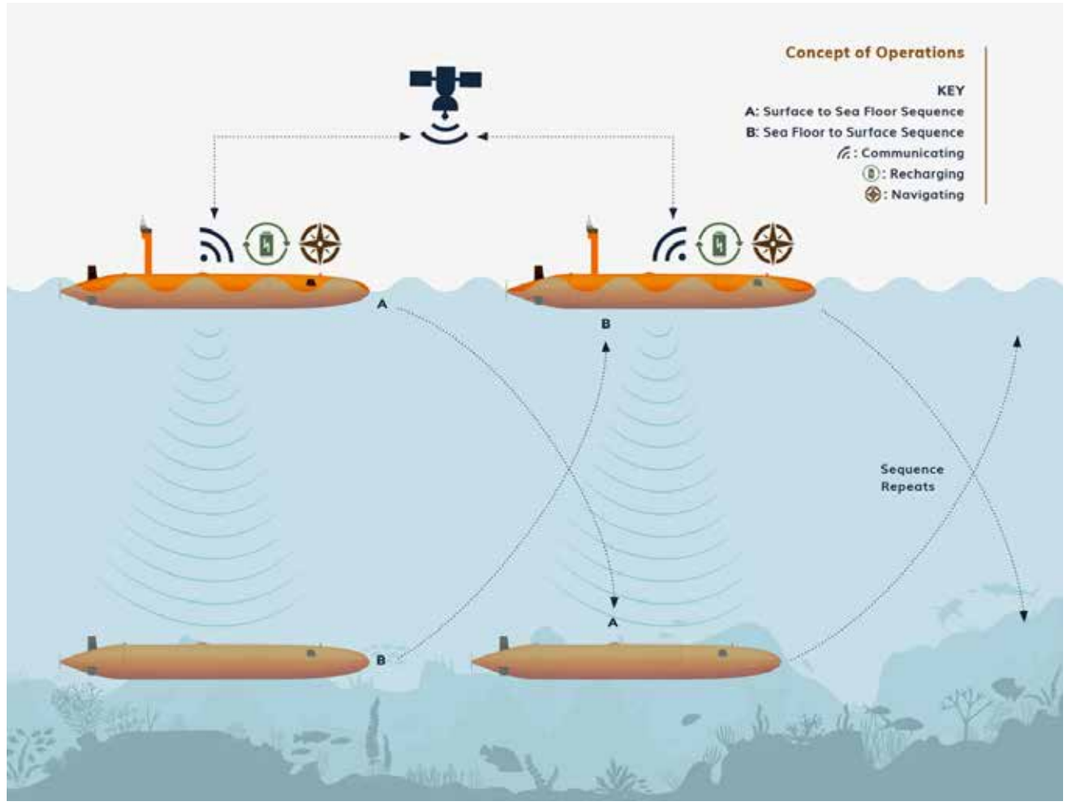
“We have not been funded by any non-profit or conservation fund to date despite having a strong conservation and ocean science aspect to what it is that we do.

"However, we anticipate providing as much information as possible to conservation and marine science entities for their own analysis and dissemination,” said Wolfel.

“Seagate Technologies, which makes about half the world's data storage, has made an investment in our company that has allowed us to understand the implications and potential of cutting-edge data storage solutions. Seagate is very interested in data mobility from edge environments and particularly long-term storage.

“Being so bandwidth constrained, the ocean is a fantastic use case for a lot of Seagate's core technology; they also have a significant corporate social responsibility and ESG aspect to what they do and what they believe in from a corporate culture standpoint.

"Understanding anthropogenic change in the ocean and stopping detrimental changes is of considerable interest to everyone - and I think Seagate’s senior leadership understands the power of data in making benevolent decisions better than most.”



The dual ROV operation

“At present, we have taken delivery of the AUV and are at the testing stage. There are two aspects to the testing that we need to complete. We integrated our own onboard data processing system into the frame in March/April of this year into the baseline vehicle.

"This will allow our onboard data processing module to carry out automatic target recognition and autonomous tasking. It means that we can conduct a mission and ingest data from the sensor the robot processes completely on board.

"Our onboard data processing module is transferable between vehicle types and is a custom integrated design predicated on NVIDIA and Intel processors.

“The onboard data processing enables automatic inferences about the data it receives and then retasks itself with no human intervention. Snippets of that data can be sent for human consumption based on the way the robot prioritises itself.

“The second piece that is critical to our concept of operation is autonomous energy recharge capability.

"We have been looking at a run time of 14 days for the prototype, but this could easily extend to 30 to 60 days depending upon fuel capacity. This is what we're integrating into the vehicle currently and anticipate commencing in water tests imminently.

"Battery technology continues to improve, which is fantastic- but the ability to autonomously recharge those batteries to run sensor payloads for significant duration is the key to scalable ocean data collection.

“We run the company from Austin, Texas, not particularly near the coast but a world center for digital communication technologies. From here, we will collect a repository of scalable, cost-efficient data that will inform and transform every industry with a connection to our oceans.”

ECOSUB

Surrey-based ecoSUB Robotics, a division of Planet Ocean Ltd is currently embarking on a £2 million Innovate UK project focused on employing its pocket AUV in swarms. The vehicles will be used in association a range of autonomous platforms under a centralised planning, monitoring and fleet management autonomy engine.

The original ecoSUB AUV concept dates back to 2015 when a group of robotics engineers from Planet Ocean & the National Oceanography Centre MARS Group began to consider the autonomous vehicle market and discuss what they would do differently.

At the time, AUVs were largely the preserve of institutes and companies with both large budgets and access to infrastructure. Instead of large vehicles, however, ecoSUB's vision was to develop micro-sized units that could be used individually to either execute smaller individual projects or alternatively, could be deployed in large numbers, closely interacting with each other.

"We didn't set out to maintain the status quo," said Iain Vincent (business development manager), "We wanted to democratise the AUV and enable its use by the wider marine science community. We saw larger vehicles on the market costing £2 million, not to mention the need for sophisticated infrastructure necessary to launch and recover these assets, and we wanted to increase the number of people that could practically enjoy the benefits of these vehicles.

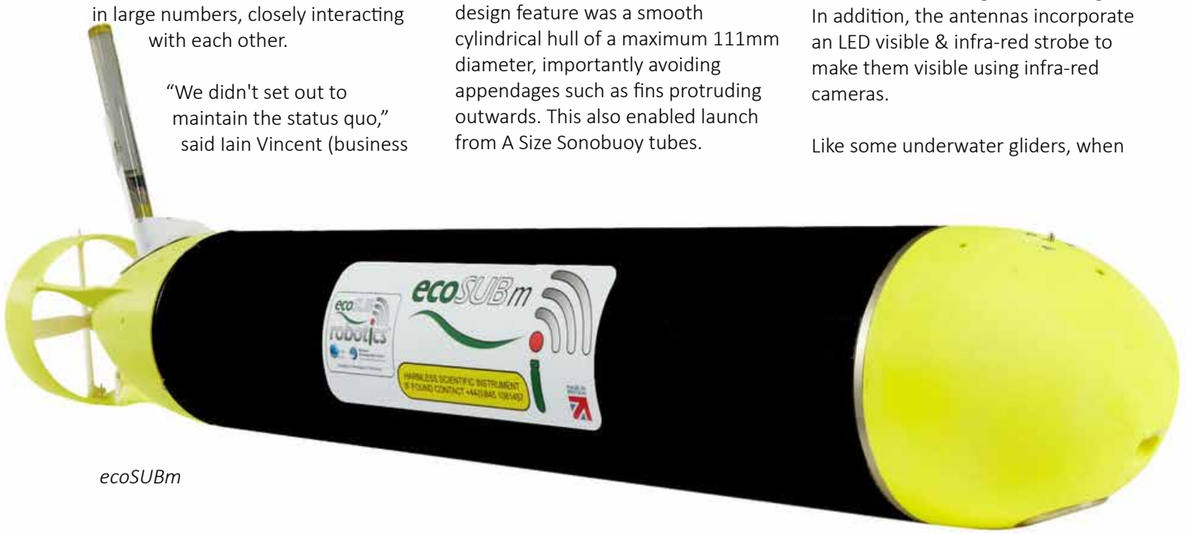
Fundamentally, it would demand a disruptive low cost vehicle design, small enough to be physically placed into the water by a single person. Its dimensions meant that it could be transported to site in cars or aircraft and could be piloted locally or remotely."

In an early iteration, the ecoSUB was to be launched through a tube and the company worked closely with ASV, (now L3 Harris) to install such launch tubes to its C-Worker autonomous surface vehicle. Tube launching meant that a vital vehicle design feature was a smooth cylindrical hull of a maximum 111mm diameter, importantly avoiding appendages such as fins protruding outwards. This also enabled launch from A Size Sonobuoy tubes.

"Designing an underwater vehicle without fins for steering or stabilisation is challenging," said Vincent. " We inserted a rudder in the Kort Nozzle just behind the propeller for lateral movement but satisfied the greater issue of pitch control by incorporating a 'moving-mass' arrangement to modify the vehicle's pitch. This manifests as a battery carriage that is able to drive itself forward along the inside of the hull. As this gradually passes across the centre of buoyancy, the nose becomes heavier and the vehicle slowly starts to dive. Conversely, moving the mass backwards causes the vehicle to rise to the surface."

In many AUVs, the comms antenna often stands within a tower arrangement, proud of main hull. In the ecoSUB-µ, however, the antenna is raked backwards along the axis of the vehicle to effectively form a tail. The antenna incorporates a GPS system as well as WiFi for short range communications transfer. It also has Iridium SBD for full global coverage. In addition, the antennas incorporate an LED visible & infra-red strobe to make them visible using infra-red cameras.

Like some underwater gliders, when the AUV reaches the surface, it can float on station with its antenna protruding upwards out of the water. ecoSUB can be fitted with acoustic nanomodems within each vehicle to enable the ecoSUBs to act as surface nodes in a Long Base Line (LBL) positioning system. This enables them to triangulate and localise themselves, position fixing with + 5 to 10 metres accuracy. Especially around the UK, the tides and currents are quite adept at moving vehicles and the position fixes ensure that the vehicles & user knows where the ecoSUBs are at all times.



ecoSUBm

"Being able to use a GPS signal and broadcast underwater using the modem allows the AUV to be used as a fairly undetectable gateway node, able to pass messages from satellite to underwater and even daisy chain vehicles for passing information," said Vincent

"Ironically, at the start, we thought that we didn't need this small AUV to be particularly intelligent in terms of its navigation as we mainly envisaged it being used for operations such as following a transect and collecting data such as, say, detecting a thermocline by measuring sound velocity. In this instance, it wouldn't be vital that the transect line wasn't exactly straight as we accepted that currents would move the small vehicle.

"Things started to change, however, when we began to engage more with users requiring geo referenced data such as side scan sonar and cameras. The later addition of a DVL, further enhanced the navigation accuracy and reduced the reliance on the LBL system.

"The original was called the micro, ecoSUB-µ5. This weighs about 4kg, is rated to 500m and is designed for relatively simple science missions, typically with single sensors suites. It is capable of measuring parameters such as conductivity, temperature, dissolved oxygen or pH. The units may incorporate devices such as a fluorometer altimeter or even a hydrophone.

"It soon became clear that there was demand for a more feature-rich single-person portable vessel with a greater payload capacity and more sensors, possibly for use in deeper waters. The result was the design of the milli- or m series, being the next size up from the original micro. It would have roughly the same length of around 1m, but a larger diameter of 146mm increasing the weight to around 12kg- still quite portable."

There are two different types of ecoSUB-m- a 500m rated version and also a 2500m model, virtually identical except for the internal ribs within the pressure hull. The extra size of the micro series gives a greater payload capacity which not