# OCEANS OF THE FUTURE

## 2.1 THE ROBOTS ARE COMING! HOW AUTONOMY IS TRANSFORMING OCEANOGRAPHY VIDEO DURATION– 07:47

Oceanographers around the world study the ocean by gathering samples and analysing water properties and features. Measurements need to be taken over large areas and at different times to build a suitably large dataset that covers the broad range of length of timescales that the ocean experiences.

For hundreds of years, these measurements have been gathered by scientists using any means they had available, from ships to simple temperature on the shoreside.

Recent advancements in technology have seen the development and use of increasingly sophisticated robotic vehicles to collect ocean data. These unmanned, autonomous robots can study the ocean for long periods, potentially spending months at sea, collecting data that can be transmitted back to shore whenever they come up to the surface and dial home via the Global Satellite Network.

Marine robots and vehicles don’t just provide an alternative to ships, but also enable scientists to gather data in places where people and ships may not be able to go, such as the deepest parts of the ocean, under ice sheets or in the very remote or dangerous seas. Before launch, the robots are given a specific set of instructions by an operator which it will follow to survey a specific area or ocean feature. The robots are then able to make decisions autonomously to optimise their passage through the ocean, such as avoiding collision or correcting their course to avoid strong currents.

The two-way satellite communications also allow the operator to keep track of the robot, monitor incoming data and send updated instructions so that a new course or strategy can be implemented.

The vehicles are designed to move quite slowly, which enables high resolution measurements to be made while conserving battery life for long endurance operations, providing a passive platform that provides minimum disturbance to the surrounding ocean and marine life.

The robotic vehicles used to study the ocean range size, shape and application.

The National Oceanography Centre’s Chief Scientist for Marine Autonomous and Robotic Systems will now talk about some of them in more detail.

**Dr Matthew Palmer:**

Autonomous vehicles come in a range of shapes and sizes, each with their own specific strengths

**Autonomous Surface Vehicles** have many applications, including the photo or video monitoring of marine areas, or gathering meteorological data, and they can also be deployed to work in tandem with other types of platforms.

One example of these surface vehicles is the UK designed and manufactured Autonaut

Autonaut is a wave-powered vehicle, that resembles a large sea-kayak, with two pairs of wings or foils set on struts at either end of the hull, and these are allow it to harness wave power to drive the vehicle forwards

AutoNaut has solar panels fitted to its deck to help recharge the batteries, and can be equipped with a fuel cell for longer deployments or where there are limits solar power such as at high latitudes.

Among the most capable of all marine autonomous systems are the Autosubs, another UK development, designed and manufactured at the UK's National Oceanography Centre.

**Autosubs** are robotic submarines which aim to dive deeper and travel farther than any other type of autonomous marine vehicle. The most recent developments are working towards depths down to 6000 metres and travelling over distances greater than 2000 kilometres. And this will provide an ideal platform for oceanographers enabling the measuring of oceans down from the surface to the seabed over thousands of kilometres without the need for a research ship.

Energy supply for propulsion and powering of sensors on board is a challenge for all underwater vehicles. Without the supply of oxygen from the atmosphere, internal combustion engines are not practical and large engine solutions used for military submarines are not feasible. Autosub, like all submarine robots therefore depend on high density batteries to provide power along highly efficient hull and sensor design to reduce its power consumption.

A further challenge for underwater robots, like Autosub, is navigation. GPS signals do not penetrate the surface of the ocean, so the vehicles are dependent on 'dead reckoning' where the sub uses its measured direction and speed to keep track of where it is going. For dead reckoning to work, however, Autosub must use a high accurately compass heading, which it does using a gyro-based sensor, that provides a heading accuracy of better than one tenth (0.1) of a degree, combined with speed measurements collected using acoustic techniques.

**Submarine Gliders** are the most common type of marine robots. These gliders are typically less than 2 metres in length and weigh around 60 kilograms, meaning they are relatively simple to deploy from small boats

Rather than using a propeller, gliders use a buoyancy engine which uses an internal pump to change its weight in the water, switching between light and heavy, to move up and down.

Similar to an aerial glider, underwater gliders use drag and lift to convert vertical motion into forward propulsion. Unlike its aerial cousin however, the submarine glider's lift comes from its specialised glider body rather than its wings, which are only there to help provide stability.

Gliders are fitted with an inbuilt compass, which they use to navigate, and while they move very slowly, usually around half or one mile per hour, the efficiency of the buoyancy engine means they can maintain this speed for many months at a time and are regularly deployed for three months or more.

At the smaller end of the scale are small, low-cost **Autonomous Underwater Vehicles** (AUVs), such as the ecoSUB. These are really lightweight, easy to launch and recover, and so can be managed by a single operator without the need of major infrastructure of facilities. EcoSUBS can also carry an acoustic modem – an underwater version of your home WiFi – which enables them to be deployed as an underwater communications network.

**Micro AUV**, such as the ecoSUB, are able to operate at depths of up to 500 meters, with a typical range of tens of kilometres, and will operate up to 24 or 48 hours, providing a short term, short range but highly effective and more manageable option for marine robotics users.

This broad range of autonomous ocean robots provides an exciting prospect for modern oceanographers. Providing the potential to measure anything, anywhere and at anytime at the fraction of the cost of traditional ship-based or fixed ocean platforms.

Each of the vehicle types are capable of carrying a range of sophisticated sensors on-board that can measure a range of different physical properties, such as temperature, salinity or mixing intensity. Other sensors enable measurements of chemical properties, such as nutrients contaminants or trace metals, and biological sensors enable fish detection and the sound and clicks of whales and dolphins.

Emerging technology is also expanding the range of available sensors.

Cutting edge, 'Lab-On-Chip' technology offers microfluidic chemistry analysis alongside miniaturised electronics and optics, that are able to gather and analyse chemical signals that otherwise require traditional large-scale laboratory facilities with highly skilled operators.

The data collected by these robots and their range of sensors help scientist to better understand both the current state and changes in our oceans and to monitor the impact such changes have on the health and productivity of our seas.

The observations and measurements that this amazing technology allows aren't, of course, made in isolation. The aim of ocean scientists is to better understand how all parts of our oceans function through a combined framework of in-situ observations, remote sensing from satellites and computer models. But these Autonomous Robotic Vehicles provide more opportunities for sustainable, repeatable observations to support a global framework aimed at improving understanding for a more predictable and better managed ocean that will help us plan for the impacts of future change.