Jellyfish as Inspiration for Propulsion

Launch of Next-generation **Wind-powered** USV

Here's a simple question: What is a bluebottle? Readers living in the temperate north will almost certainly think of a large, hairy fly buzzing around just out of reach. But for Australians, a bluebottle brings to mind a diminutive blue jellyfish, swarming menacingly off the beaches of the East coast; the cause of many hastily-abandoned swims. Australian bluebottles are remarkable creatures and inspiration for a new generation of Unmanned Surface Vessels (USVs) coming to market from Ocius Technology.

▲ *Figure 1: Australian bluebottle (Physalia physalis). Image courtesy: Matt Smith.*

So what is it about bluebottles that makes them so special? For a start they are comprised of several individual interdependent organisms (polyps) working in perfect symbiosis. They sport different tentacles for different tasks such as fishing, stinging, eating and reproducing. They can also sail. Yes, you heard that right; bluebottles harness the power of the wind by contracting the crest of a gas-filled 'float' on the ocean surface. In other words, bluebottles have evolved a degree of autonomy as to where they go. Unlike lesser jellyfish, they refuse to be at the mercy of ocean currents.

In many respects the bluebottle is nature's ultimate 'unmanned autonomous surface vessel' and fitting inspiration for the painstaking USV design work by the team at Ocius Technology. The team regularly sees (and feels) these critters close up, being based in prime bluebottle territory: the coast of New South Wales, Australia.

Design Evolution

With the support of investors, shipbuilders Steber International and world class facilities at the University of Wollongong SMART lab, Ocius founder Robert Dane and CTO Ninan Matthews have built an entirely new type of vessel right up from first principles of hydrodynamics and naval architecture. The team has extensive experience from 14 years of work with renewable energy marine propulsion systems. In 1999, Dane, an avid

▲ *Figure 2: Ocius 2.8m USV manoeuvring using wave & wind energy in moderate winds in Sydney Harbour.*

sailor and former medical doctor, won a solar boat race in a vessel he designed himself. The company he founded, Solar Sailor, went on to patent and install solar sails and hybrid drives on passenger ferries around the world.

The Ocius team has had the additional advantage of watching the market in USVs emerge and develop for a period, taking note of what industry customers really need. In business-speak it is called being a 'fast follower'.

Many autonomous USVs have been plagued by low speed and manoeuvrability, low power and small payload space, rendering them largely ineffective as hydrographic platforms. As such, 'Power, Payload & Persistence' has been the Ocius mantra throughout the design process. But how does that translate in reality?

Harnessing All Energy at Sea

Much like the polyps of a real bluebottle, the Ocius USV design uses a combination of propulsion systems that harness all renewable power sources available at sea: wind, solar and wave energy.

This is abundantly evident from seeing the latest thin film marine PV panels installed on the deck and the hinged rigid sail for powering on-board electronics.

They refuse to be at the mercy of ocean currents

Rudder mounted wave-oscillators passively extract energy from the pitching of the vessel caused by ocean waves to provide forward propulsion in the direction of the rudder heading. The system has some parallels with that used by US firm Liquid Robotics but here they are fixed to the hull and use expired

▲ *Figure 3: Ocius USV self-deploying using active electric propeller power only.*

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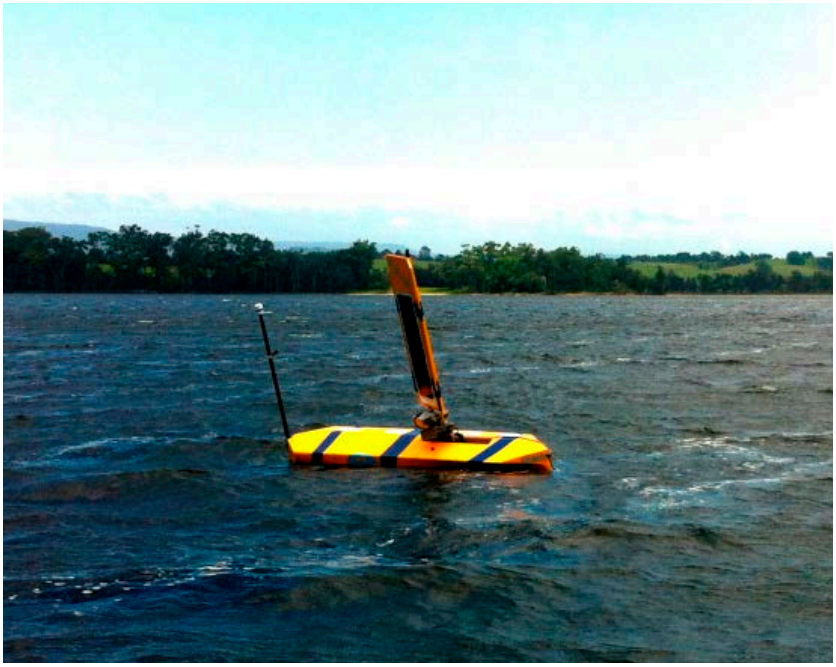

▲ *Figure 4: Ocius 2.8m USV manoeuvring in heavy winds in Jervis Bay, NSW, Australia.*

Norwegian patents with additional patents pending.

Finally, the elegant, stowable rigid opening sails are what really set this vessel apart. Coated in yet more thin film PV, they collect both solar energy and the wind, using traditional sailing to propel the USV, increasing the speed, endurance and stored power of the platform.

Autonomous sailing is simpler than it sounds

High and Low Available Natural Power

Autonomous sailing is simpler than it sounds. Autopilots on yachts have been around for decades, so Ocius has adapted some of that technology, integrating it with the navigation system. Also, the flat opening shape of the sails means the vessel does not have to tack or gybe in the traditional manner and gives it a large surface area, perfect for catching the wind and the sun.

All in all, the bluebottle can achieve a 'meaningful speed of advance' of 2 knots in almost all conditions by harnessing the environmental forces acting upon it.

In conditions over Beaufort 5 the vessel folds the sail down onto the deck and presents 'like a cork' in the sea using its rudder/ wave oscillator to passively harness the energy of the ocean as the vessel 'pitches' and 'rolls' to drive it forward and maintain a heading at a safe distance from a 'lee shore' to ride out the storm. With its centre of gravity below its centre of buoyancy it is always self-righting.

In the worst case scenario, if the sun does not shine and the wind does not blow, the bluebottle has 3 to 5 days system power stored in batteries, which act as useful ballast. The batteries power the vessel via its propeller at up to 2 knots for 24 hours or give kilowatt bursts for short periods. There is even space for an optional methanol-hybrid fuel cell for use in highly energetic waters or in emergencies.

Payload Bays

Like the bulbous bluebottle jellyfish, the 40 litre/40kg customer dry payload space afforded by the 2.8m bluebottle design is sufficient to install a variety of customer-specified sensors, surveillance and comms systems.

A 10kg/10l 'wet' payload bay in the keel offers added space for oceanographic sensors and the hull is designed by Stebercraft International to be strong enough to attach a high-resolution MBES. Sea trials with an affixed MBES have been successful even with the vessel at sail, where heeling is kept to a minimum due to the deep hull design.

The aim is to be able to accommodate most/any hydrographic gear and computing power required for sustainable and indefinite mapping without adding fuel cells or fossil fuel.

Conclusion

The bluebottle system has proven its capabilities as a way of propulsion and it is ready for market as a highly effective long-term marine sensor, surveillance and towing platform. Ocius is confident it will see service across the world's oceans and in various industries. The bluebottle will come in three different sizes to meet the needs of our customers beginning with the 2.8m oceanographic version. Yes it is a cliché but the company is calling this one *Nemo*. ◀

Robert Dane

Robert Dane is founder and CEO of OCIUS Holdings Limited. Robert invented and patented SolarSails in 1996. The prototype won the Advanced Technology Boat Race in Canberra in 1997. The first commercial vessel won the Australian Design Award of the Year. Robert is a passionate sailor and an Intel Environment Laureate. This year Robert was honoured to be awarded the WWF future maker's award.

William Greene

William Greene heads up Ocius' European business development activities across the hydrographic, defence and offshore energy industries. He previously worked as a senior renewable energy investment analyst for Australia-based investment bank Driftwood Capital and has more than 10 years experience with leading energy advisory firms.
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Ninan Mathew

Ninan Mathew has a Master's degree in Mechanical Engineering with Distinction from the University of Wollongong. He worked as a research engineer for several ARC projects during his studies at UOW and has a number of publications to his name. Ninan brings his expertise in Computational Fluid Dynamics (CFD), Finite Element Analysis (FEA), 3D modelling, project management, machine design and several other niche areas for which he has been teaching at the university for the past four years.

More Information

Ocius' *Nemo* USV going through its paces in Australia
https://www.youtube.com/watch?v=xdiBbEQOMOA&spfreload=10