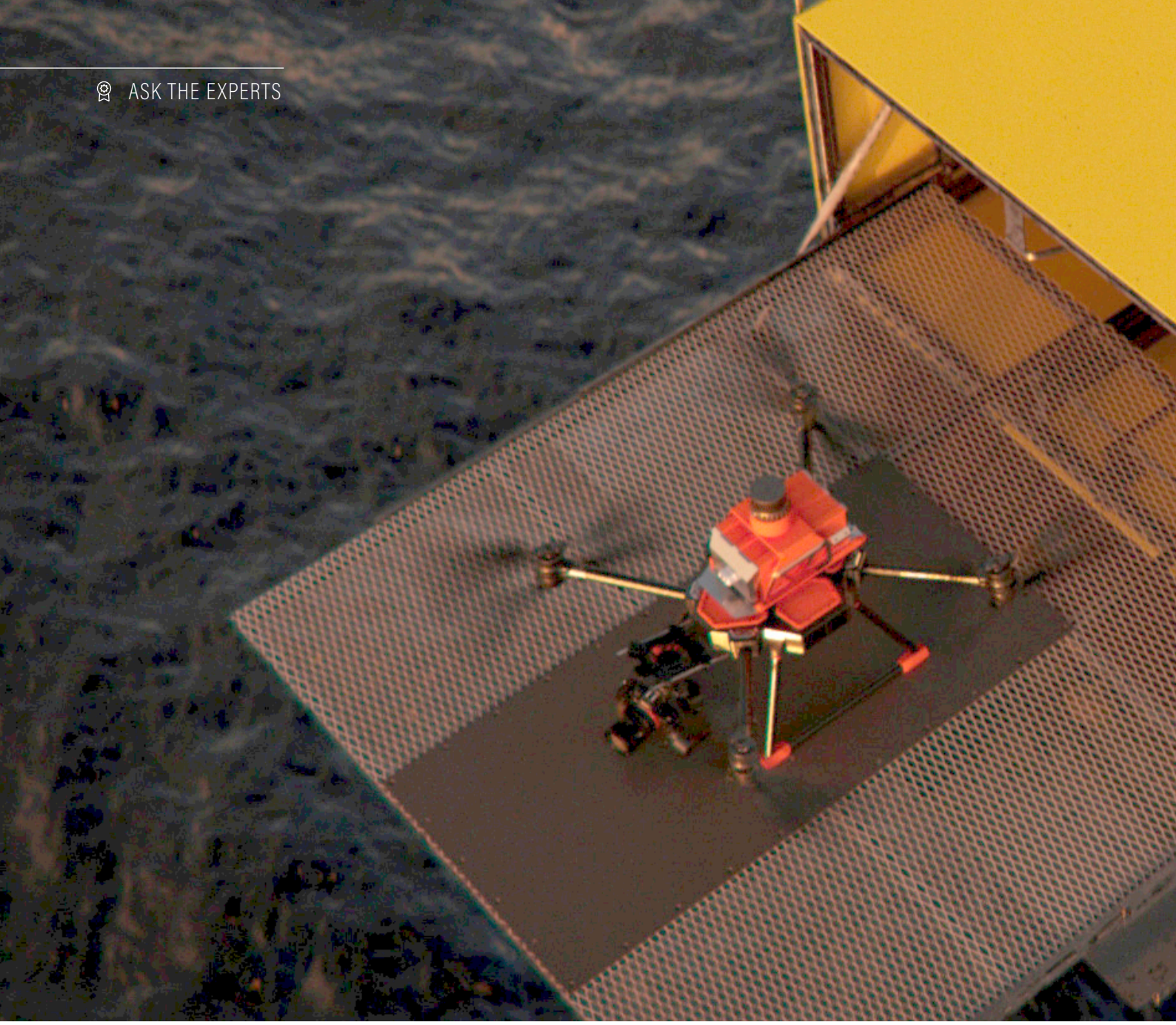
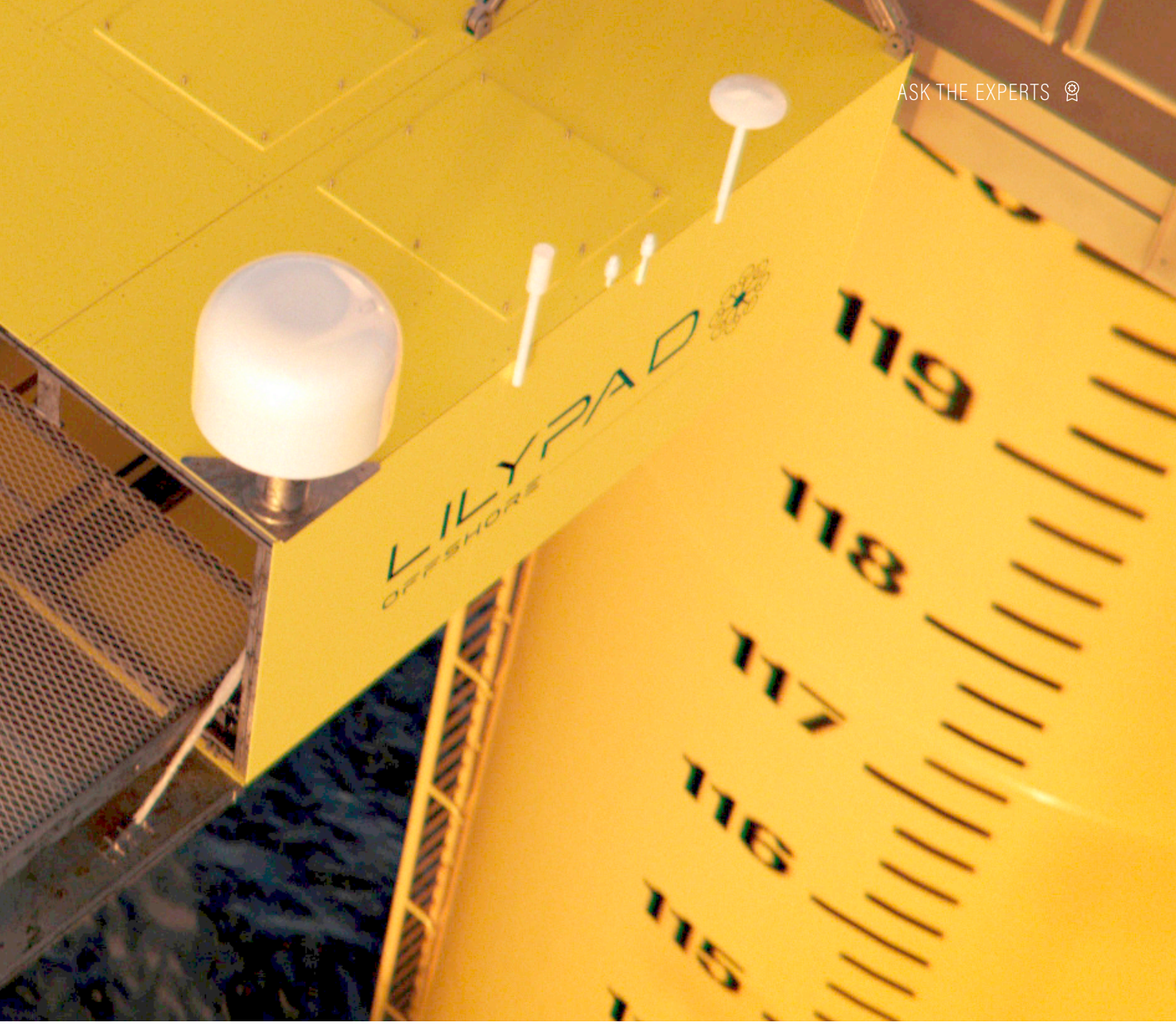


Automated inspection set for a vital role in the future of offshore wind

As we look ahead to a prolonged rise in global demand for renewable energy, it's clear that offshore wind is primed for explosive growth. The opportunities are significant and abundant, but so are the questions, including how operators can efficiently and quickly scale up and maintain capacity.



According to Kieren Paterson, Managing Director of UK-based Marshall Futureworx, part of the solution is increased use of automated inspection technologies. This year, the group launched its first product, Lilypad, which uses beyond visual line of sight (BVLOS) UAVs to provide dynamic on-demand inspection services for offshore wind operators.

We caught up with Kieren to hear his thoughts on how cross-sector collaborations can deliver BVLOS inspection and maintenance at scale, unlocking the efficiencies that will take offshore wind to new heights.

PES: It's great to speak with you Kieran. Could you start by introducing Marshall Futureworx?

Kieren Paterson: We are the venture-building arm of the Marshall Group, an independent company based in Cambridge, UK. The Futureworx mission statement is to identify and develop products and services that address global and societal problems of practical significance. We do this by harnessing emerging global trends, technology and partnership opportunities.

By comparing the future and present-day states based on those global trends, we're able to identify great ideas and turn them into new ventures by launching them as start-ups inside Futureworx. That's exactly what we are doing with Lilypad.

PES: What's the best way to describe Lilypad, your first product?

KP: Lilypad is an ecosystem of multiple resident autonomous BVLOS UAVs that aims to revolutionise how offshore wind energy operators inspect and monitor their offshore wind farm assets.

The UAVs are deployed from dedicated offshore charging stations to undertake on-demand or scheduled inspection data gathering using state of the art command and control, navigation and collision avoidance software. Everything is monitored by a single remote pilot stationed in an onshore command and control centre. Consistent and repeatable inspection data and reports are transmitted back to the wind farm operators, enabling more effective utilisation of assets and

Kieren Paterson

faster, more frequent and more reliable predictive maintenance.

Lilypad is intended to be operated on an 'as-a-service' basis, outputting inspection data insights to customers in an industry standard format. It is a collaboration between Marshall Futureworx as experts in complex system development and integration, ISS Aerospace who offer best-in-class industrial UAVs, and sees.ai who are leaders in automated BVLOS drone guidance and control software.

PES: Where did the idea come from?

KP: I should start by explaining that Futureworx is a young organisation that started as a blank slate, with a simple mandate to research problem spaces of the future and identify opportunities across several identified technology trends.

In our first year, those trends included uncrewed autonomy, energy, big data, and net zero amongst others.

Uncrewed aviation was a logical step for us, particularly since our parent group has a long history of aerospace engineering. As well as thinking about what would be technically possible, we wanted to focus on what would be feasible from societal and regulatory standpoints given considerations around noise, privacy and safety, among other things.

Meanwhile, exploring trends around energy gave the Futureworx team insight into offshore wind farms and their growth predictions and potential, especially in the favourable shallow waters of the North Sea off the UK coastline. What we found is that incumbent Visual Line of Sight (VLOS) UAV blade inspection methods, e.g., a pilot on a boat with a drone, or a person on an abseil rope, did not appear to scale economically when the number of commissioned turbines rapidly increases and wind farms move further offshore.

We also identified opportunities to directly address some of the major inspection-related logistical and operational challenges facing wind farm operators. For example, inspections must be booked weeks or months in advance, a logistically complex undertaking compounded by the fact that a host of conditions must be favourable in order to proceed on the day. If these conditions are not met and inspections cannot be conducted, operators incur expenses nonetheless.

In light of this, we saw a chance to add value by providing a service that performs on-demand inspections to suit current conditions. Scheduling inspections dynamically in such a manner can dramatically improve operational efficiency while building in significantly more flexibility to make the best use of favourable weather windows.

This is where the potential of the idea started to mature: we had zeroed in on an industry with a suitably remote location and a source of inherently accessible electricity, where UAVs are already used for inspections, and where operational efficiency has plenty of scope for improvement.

Lastly, we looked at net zero and decarbonisation, where renewable energy operations and maintenance activities continue, somewhat ironically, to rely on high mileage movements of personnel offshore. Yet again, we saw opportunities, in this case, to remove the need for at-turbine human presence during inspections, cut back on vessel carbon footprints, and simplify logistics by reducing or eliminating competing tasks.

Adding all of these opportunities across these trends led us to Lilypad.

PES: Would wind farm operators need to make substantial changes to accommodate the system?

KP: The number of required enclosures will be tailored to each wind farm based on a number of factors, namely the number of turbines, distance between turbines and their general arrangement, and the time period in which the client seeks to complete 100% of routine inspections. During customer setup, the Lilypad Operations Team will determine how many inspection UAVs and enclosures are required to achieve the optimal and most cost efficient inspection service.

More broadly, one of the main objectives is to remove operational burden from the wind farm owner or operator. Accordingly, the operations team will handle installation and commissioning through to UAV operation, approvals and data acquisition, secure storage and post processing.

PES: More broadly, how would you summarise the operational benefits of BVLOS offshore wind inspection?

KP: First, a BVLOS system such as this lets operators maximise wind turbine uptime, and revenue generation, by dynamically

scheduling maintenance inspections around particular weather conditions or in parallel with other activities, whilst also providing the option to conduct immediate ad-hoc maintenance inspections.

Similarly, predictive maintenance and early identification of faults, or the ability to monitor faults on an ongoing basis, will reduce the cost of repairs and maximise through-life earnings.

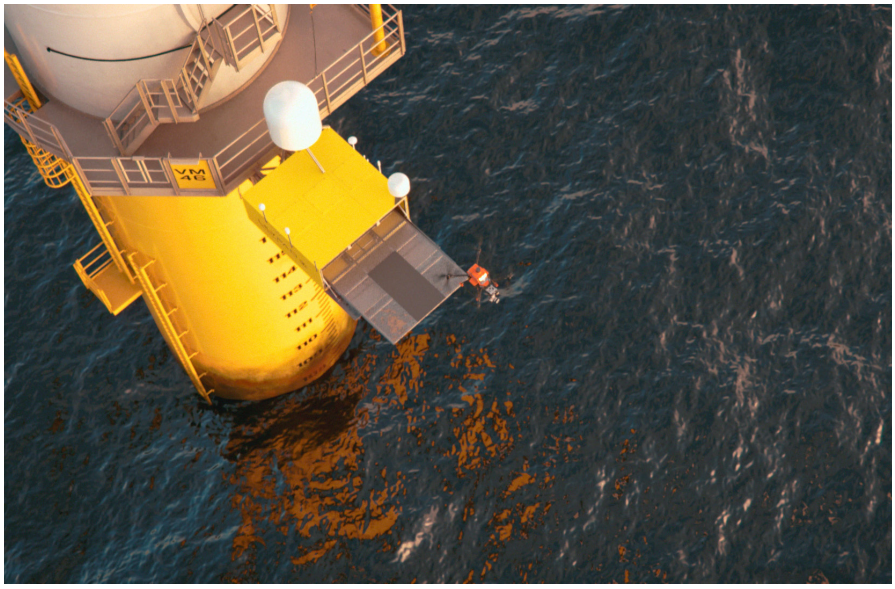
Obviously, having resident UAVs will also minimise human exposure to operations, thereby removing personnel from dangerous working environments, while also reducing offshore boat transport miles.

Lastly, scheduled and on-demand inspections with such a system will empower operators with high-quality, consistent data collection and analytics.

PES: How easy is it to scale up such a system?

KP: Put simply, the Lilypad ecosystem is very scalable! A single remote pilot can task and monitor multiple inspection UAVs, obviously without crew transfer vessel transportation costs, emissions or time.

The system's infrastructure is agnostic of distance from shore and does not scale linearly with the number of turbines. Labour and carbon costs do not increase with transfer times between shore and wind farm, making it ideal for wind farms in further offshore, deeper waters. This is a fundamental difference to incumbent inspection providers.



Crucially, the system takes advantage of the fact that enclosures mounted on turbines can act as 'staging posts' in relatively close proximity to one another, somewhere a UAV could safely land, re-power, take-off and continue after an overnight stop if needed.

Adding any number of these nodes to 'leapfrog' along will increase range indefinitely. A mesh network of enclosures can therefore cover large areas, again, scaling incredibly easily with next to no operator burden.

We see this scalability is a vital advantage of the Lilypad approach, especially given the broader direction of travel in the energy sector. The UK, for example, currently has about 12GW of installed offshore capacity; this is set to grow roughly fourfold to about 50GW by 2030, before potentially doubling again to 100GW by 2050.

I think it's fair to say that incumbent inspection systems will struggle to keep pace with plans for exponential growth in installed capacity. This is yet another reason I believe Lilypad is in exactly the right place at the right time. More information will be available when the product is first publicly showcased during the Global Offshore Wind Exhibition in London on 14th June, at Stand A66.

https://marshallfutureworx.com/lilypad