

Rolls-Royce swarm robots to inspect engines

ROLLS-ROYCE has demonstrated an exciting vision of how robotics could be used to revolutionise the future of engine maintenance. Bringing another element of its IntelligentEngine vision to life, Rolls-Royce teamed up with academics from the University of Nottingham and Harvard University to discuss and demonstrate a wide range of potential future technologies from 'snake' robots that work their way through the engine like an endoscope, to miniature, collaborative 'swarm' robots that crawl through the insides of an engine.

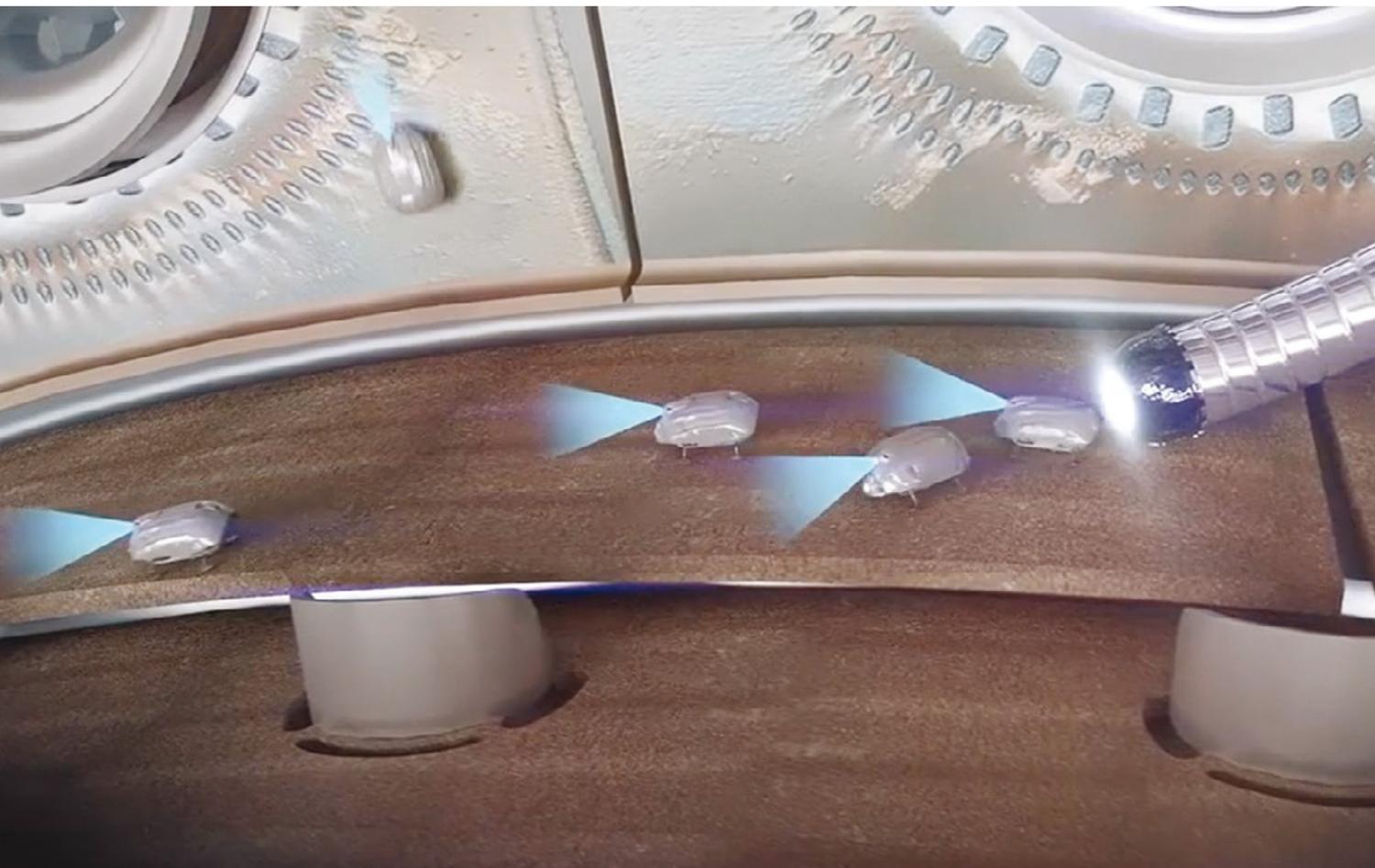
The IntelligentEngine vision, first introduced by Rolls-Royce earlier this year, describes a world where product and service have become so closely connected that they are inseparable. This vision drives activity across a range of fields, including robotics, with a particular focus on digital technologies.

The robotic technologies displayed each represent an opportunity to improve the way engine maintenance is delivered, for example by speeding up inspection processes or by removing the need to take an engine off an aircraft in order to perform maintenance work. This has the potential to

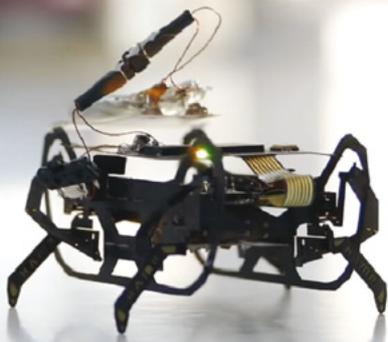
offer significant benefits for customers by reducing the cost of engine maintenance, increasing the availability of an engine and ensuring any maintenance required is completed as quickly as possible.

The technologies are at varying levels of maturity, and include:

- **SWARM** robots – a set of collaborative, miniature 'cockroach robots', each around 10mm in diameter which would be deposited in the centre of an engine via a 'snake' robot and would then perform a visual inspection of hard to reach areas by crawling through the engine. These robots would carry small cameras that provide a live video feed back to the operator allowing them to complete a rapid visual inspection of the engine without having to remove it from the aircraft. This project is a partnership between Rolls-Royce, Harvard University and University of Nottingham.
- **INSPECT** robots – a network of 'periscopes' permanently embedded within the engine, enabling it to inspect itself using the periscope cameras to spot and report any maintenance requirements. These pencil-sized robots are thermally protected from the extreme heat generated within



'Snake' robots would be flexible enough to travel through an engine like an endoscope and collaborate with cockroach robots to carrying out patch repairs.



Miniature 'cockroach robots', each around 10 mm in diameter, would perform a visual inspection of hard to reach areas by crawling through the engine.

an engine and the visual data they create would be used alongside the millions of data points already generated by today's engines as part of their Engine Health Monitoring systems. This project is a partnership between Rolls-Royce, Oxsensis, BJR Systems, Roke Manor and the University of Nottingham.

- Remote bore-blending robots – teams from Rolls-Royce and the University of Nottingham have worked together to develop a robotic bore-blending machine that can be remotely controlled by specialist engineers. In practice this means that complicated maintenance tasks, such as repairing damaged compressor blades using lasers to grind parts, could

be completed by non-expert 'local' teams who would simply install the tool in the engine and then hand control of it over to a dedicated expert back in Rolls-Royce's Aircraft Availability Centre who would then direct its work remotely. This removes the need for specialist teams to travel to the location of an aircraft needing maintenance, vastly reducing the time required to return it to service.

- FLARE – a pair of 'snake' robots which are flexible enough to travel through an engine, like an endoscope, before collaborating to carrying out patch repairs to damaged thermal barrier coatings. This project is a partnership between Rolls-Royce, University of Nottingham and Metallisation.

Richard Goodhead, Rolls-Royce, Senior Vice President – Marketing, said: "The advancements we are making in robotics are a great example of us bringing our IntelligentEngine vision to life. By exploring how we might use the rapid progress we are seeing in fields such as digital and robotics, we are ensuring that Rolls-Royce will continue to lead the way in service innovation, offering the very best value for our customers."

Dr James Kell, Rolls-Royce, On-Wing Technology Specialist, added: "While some of these technologies, such as the SWARM robots, are still a long way from becoming an everyday reality, others, such as the remote bore-blending robot, are already being tested and will begin to be introduced over the next few years. We have a great network of partners who support our work in this field and it is clear that this is an area with the potential to revolutionise how we think about engine maintenance."

Read more at: <https://www.roboticsresearch.ch>

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