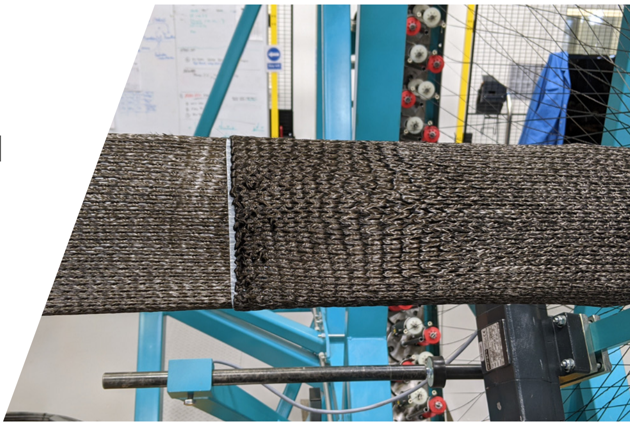
The University Of Sheffield.

AMRC Advanced Manufacturing Research Centre

AMRC Composite Centre
Case Study

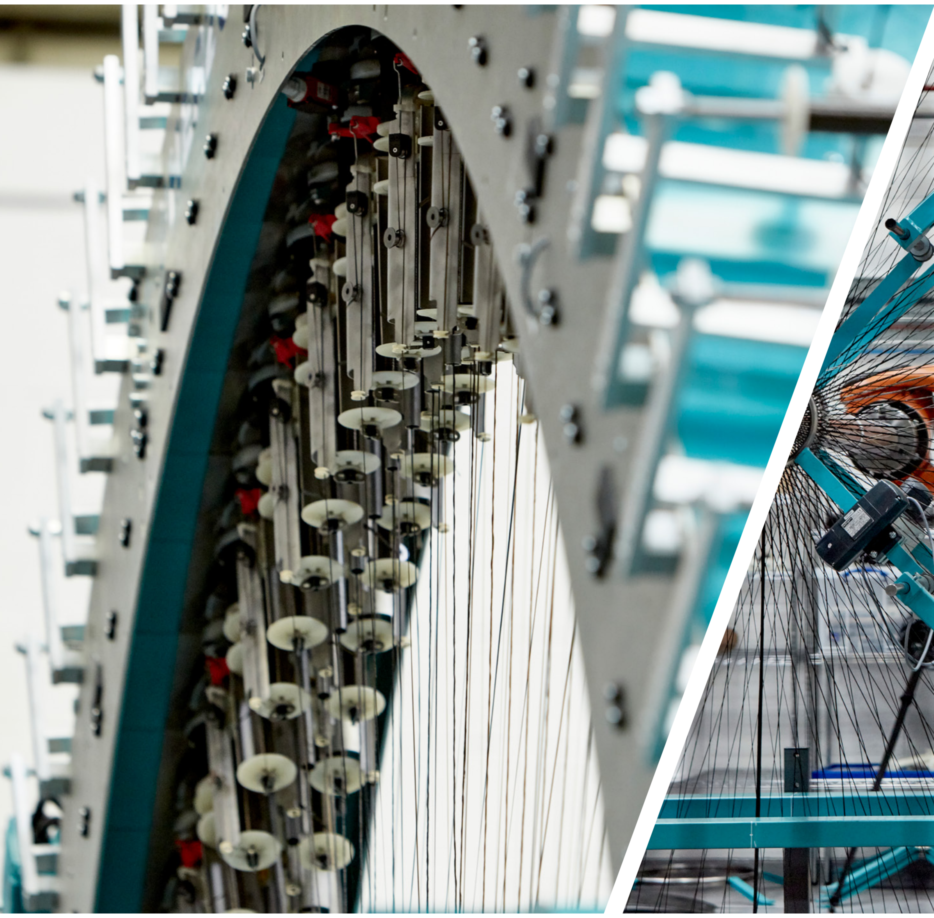
DigiProp: Propelling air travel to a sustainable destination

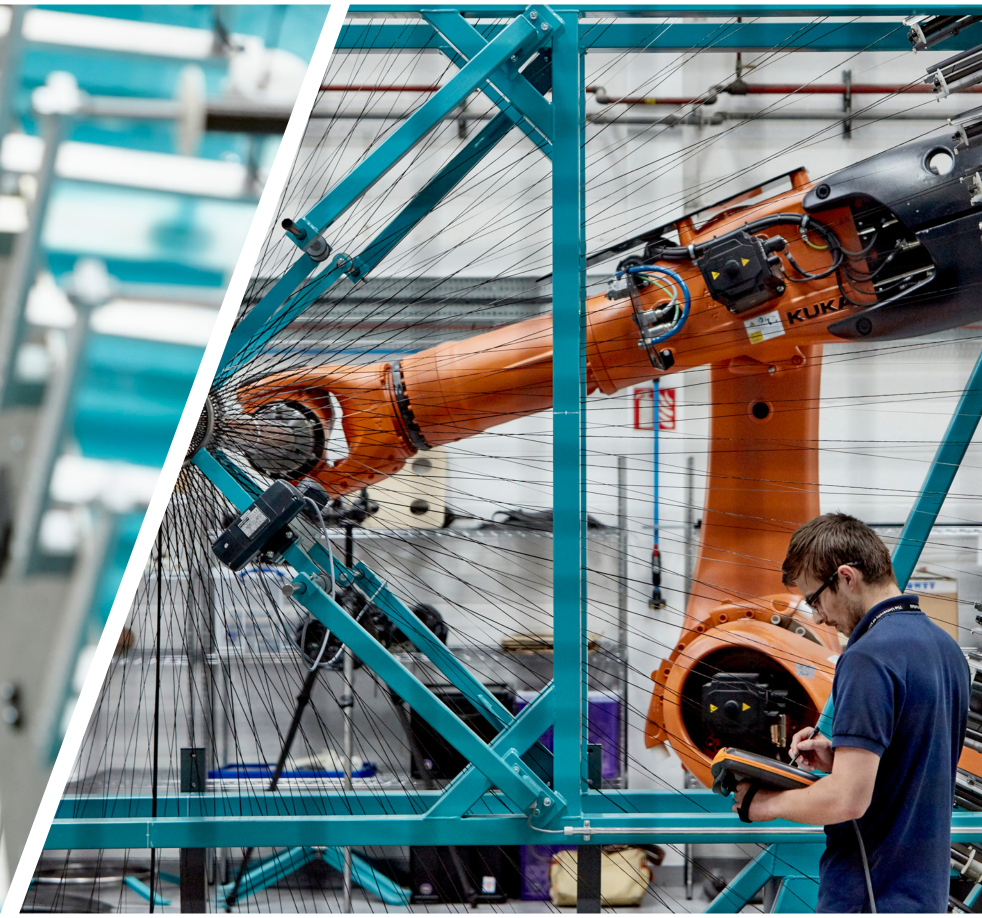
AMRC Technology Development: Complex Braiding



Challenge

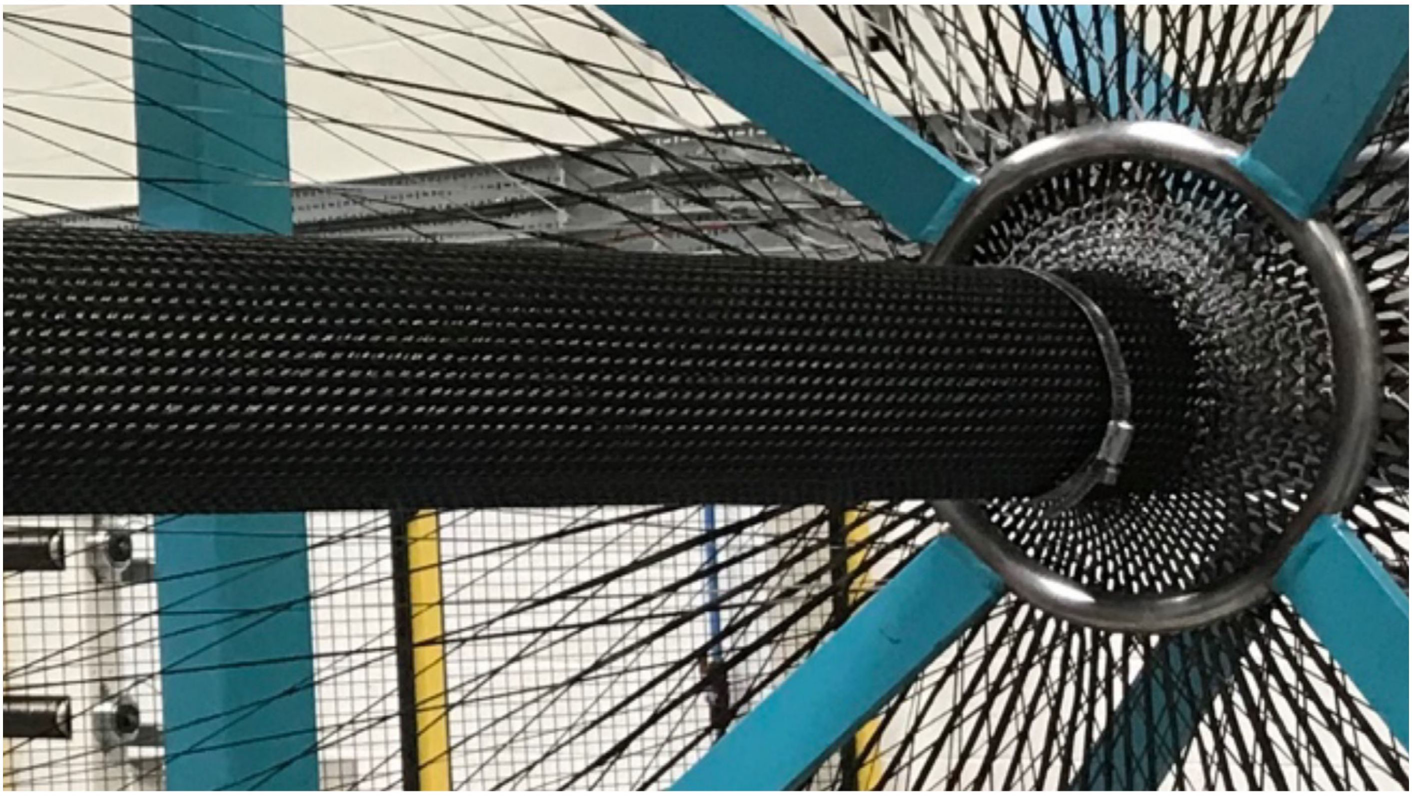
Develop and scale-up an automated, efficient aerofoil manufacture process to support Dowty Propellers' flexible manufacturing capabilities of complex blade geometry for its next generation composite propeller blades.





Watch our braiding technology in action

CATAPULT High Value Manufacturing

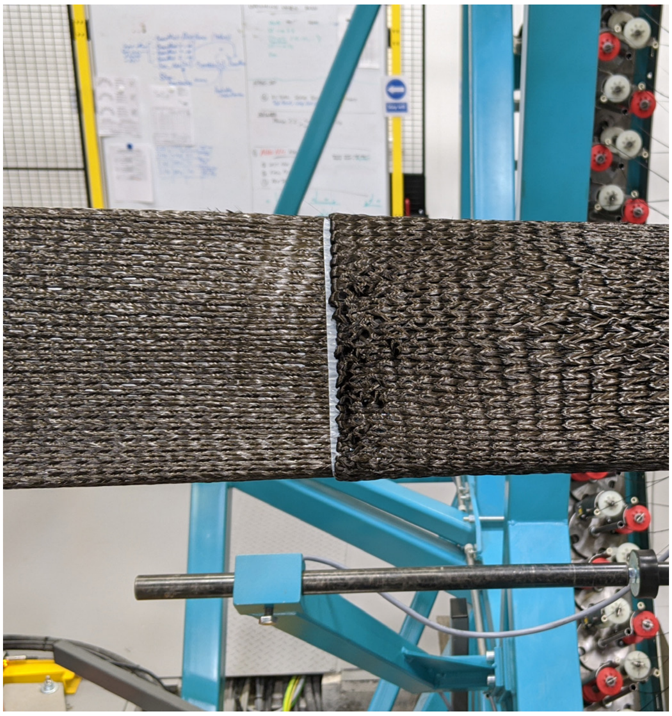


Development trials were conducted on tubular mandrels to optimise the machine set-up to produce the desired complex braid structure.

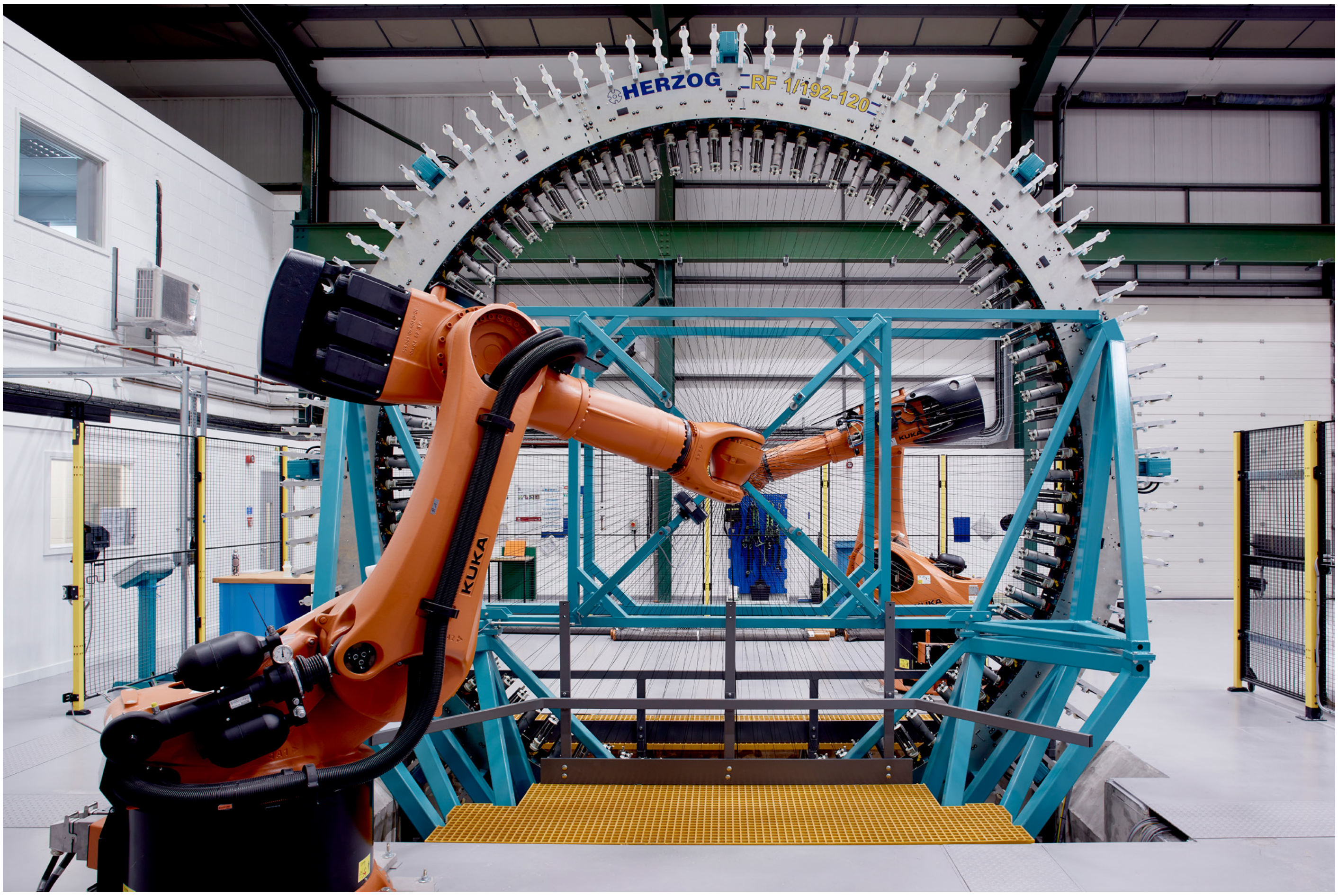
Background

Demand for cleaner and cheaper air travel has never been greater with net zero and jet zero targets for 2050. To meet this demand, it is vital the UK maintains and extends its world-leading capability in sustainable aviation propulsion technologies. It is also key to achieving Europe's Flightpath 2050 vision for the European aviation community to lead the world in sustainable aviation products and services.

In 2017, a £20m four-year project was launched to develop lightweight propeller blades that will help the UK aviation sector reduce its carbon footprint and noise emissions at airports. Led by Dowty Propellers (part of GE Aviation Systems), it was supported by three High Value Manufacturing Catapult centres: the University of Sheffield AMRC, the National Composites Centre and the Manufacturing Technology Centre. The project harnessed composite technologies with industrial digitalisation to cut production costs and increase performance of future propulsion systems to grow the UK's aerospace propeller manufacturing base within Europe's €200bn aviation sector.



Methods to reverse the ply on the mandrel, without cutting the material, were developed as part of the automation development.



The AMRC's Herzog radial braiding cell with composite braiding capability and dual robot part manipulation.

Innovation

The AMRC has pushed the boundaries of what is capable with composite manufacturing to overcome the challenges of scaling up manufacture for the braiding of complex geometry by developing an automated process for Dowty Propellers using a large-scale robotic braiding machine capability.

Dowty Propellers plans to continue using braiding technology for its next generation of blade designs, with increasingly complex aerodynamic shapes. These quieter, more efficient geometries are beyond the limits of Dowty Propellers current braiding technology. The AMRC set out to advance this capability for Dowty Propellers by developing a process to braid a complex blade geometry by making use of advanced robotic process control. This allowed for greater design freedom to pursue the most efficient aerodynamic blade shapes, as well as more precise tailoring of the braid fibre orientation, making the blade lighter without compromising on stiffness and strength.

The AMRC used its large-scale Herzog robotic complex braider to manufacture a single-shot, load-bearing structure directly onto a core mandrel that could withstand the majority of bending and torsional loads combined. By automating the process - removing the need for the manual laying up of materials which Dowty Propellers does currently - this reduced the number of manufacturing steps in the process, making it more efficient.

Purchased as part of a £3.2m ATI-funded bid, the triaxial braider is a key part of the AMRC's dry-fibre development capabilities alongside 3D weaving and tailored fibre placement (TFP) technologies.

The 6m diameter braiding system allows for the development of manufacturing complex architectures and features with dry fibre technology, offering the ability to tailor orientations to suit structural requirements as well as allowing both off-axis and axial fibres to be laid simultaneously at the deposition rates required for high-volume manufacture.

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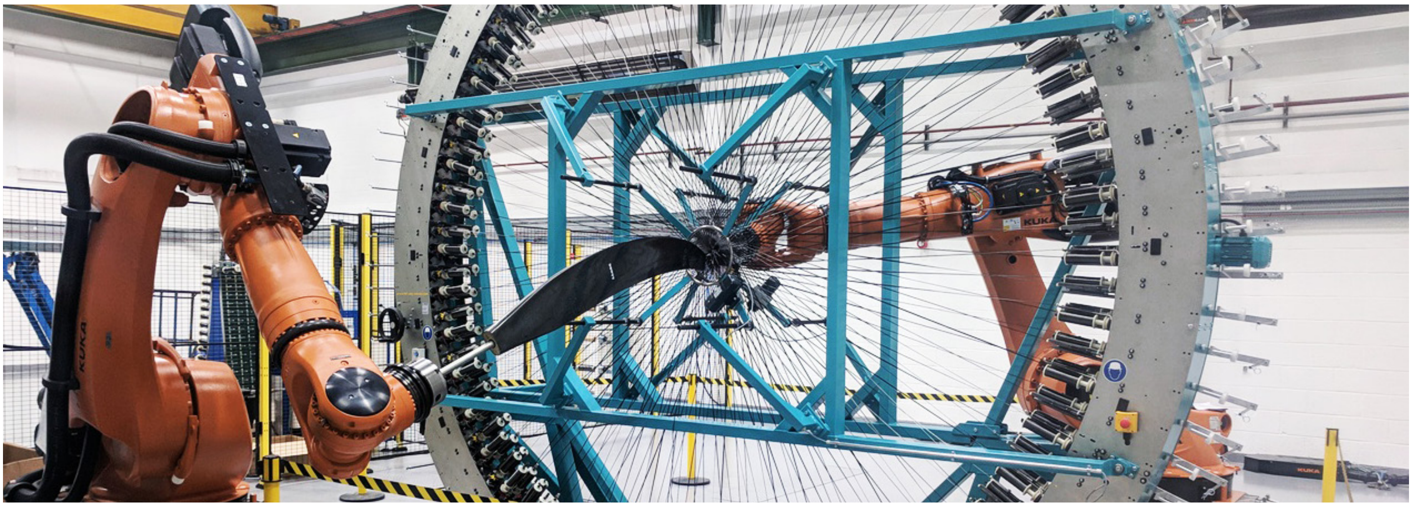


The braiding development involved trials with complex aerofoil geometries which could be manipulated through the braiding ring utilising the advanced robotic control system.

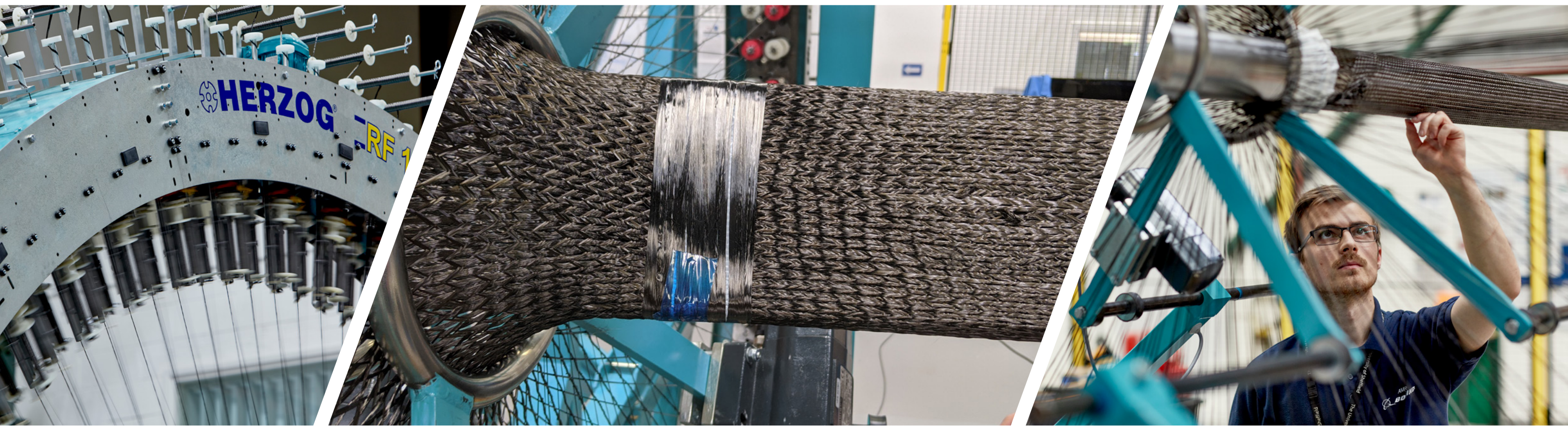
Result

Through the DigiProp programme, the AMRC Composite Centre has been able to push the boundaries of the possible to advance the current state-of-the-art for complex braiding, overcoming challenges for upscaling a braiding structure and for automating the process to:

- Braid a complex geometry aerofoil with designed ply lay-up;
- Transfer knowledge to Dowty on complex braiding, machine set up, scaling and automation;
- Advance and deepen the AMRC's knowledge on braiding.

Impact

The work undertaken as part of the DigiProp programme proves that complex aerofoil and other non-axisymmetric shapes are possible with complex braiding. The AMRC Composite Centre is continuing to build its knowledge base in this process and is undertaking follow-on projects with other aerospace partners. The technology has huge potential for future manufacture and is applicable to many industries as well as aerospace including automotive, gas and oil, renewables and construction.



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