The University Of Sheffield. AMRC Advanced Manufacturing Research Centre

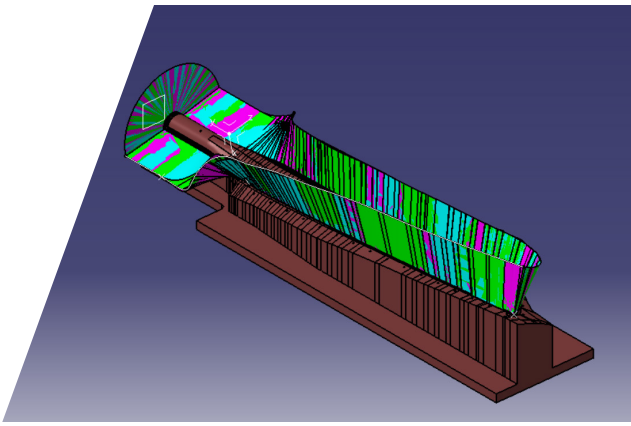
AMRC Composite Centre
Case Study

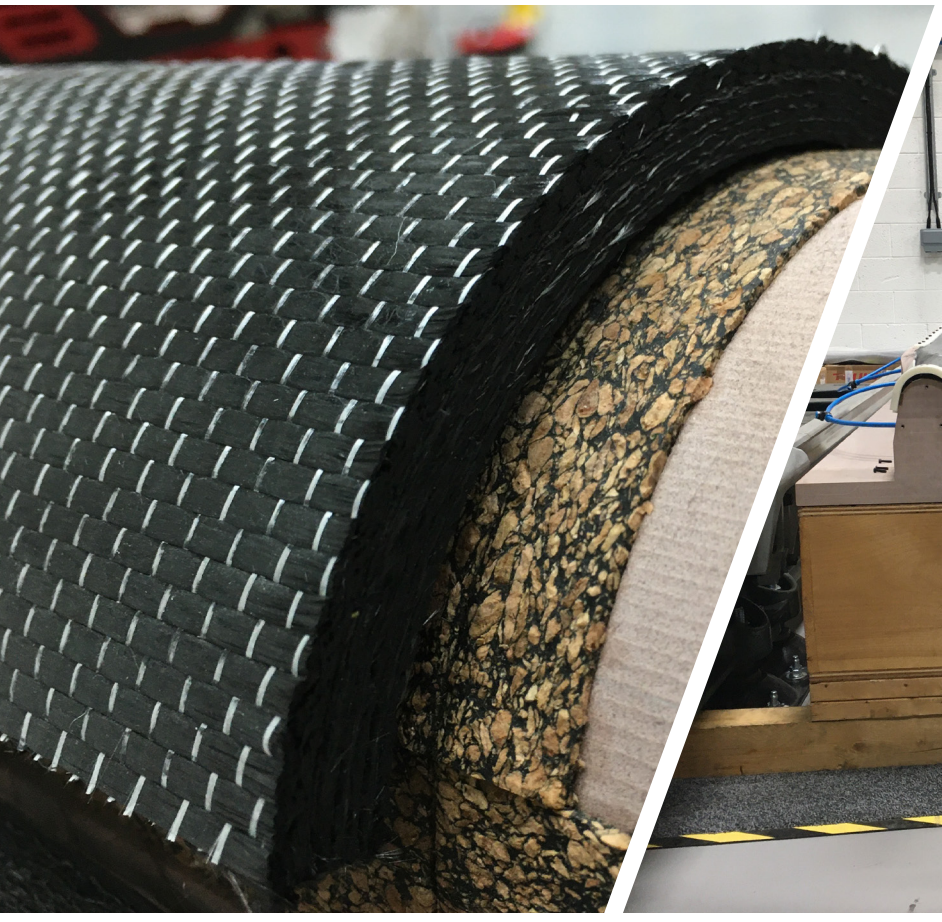
DigiProp: Propelling air travel to a sustainable destination

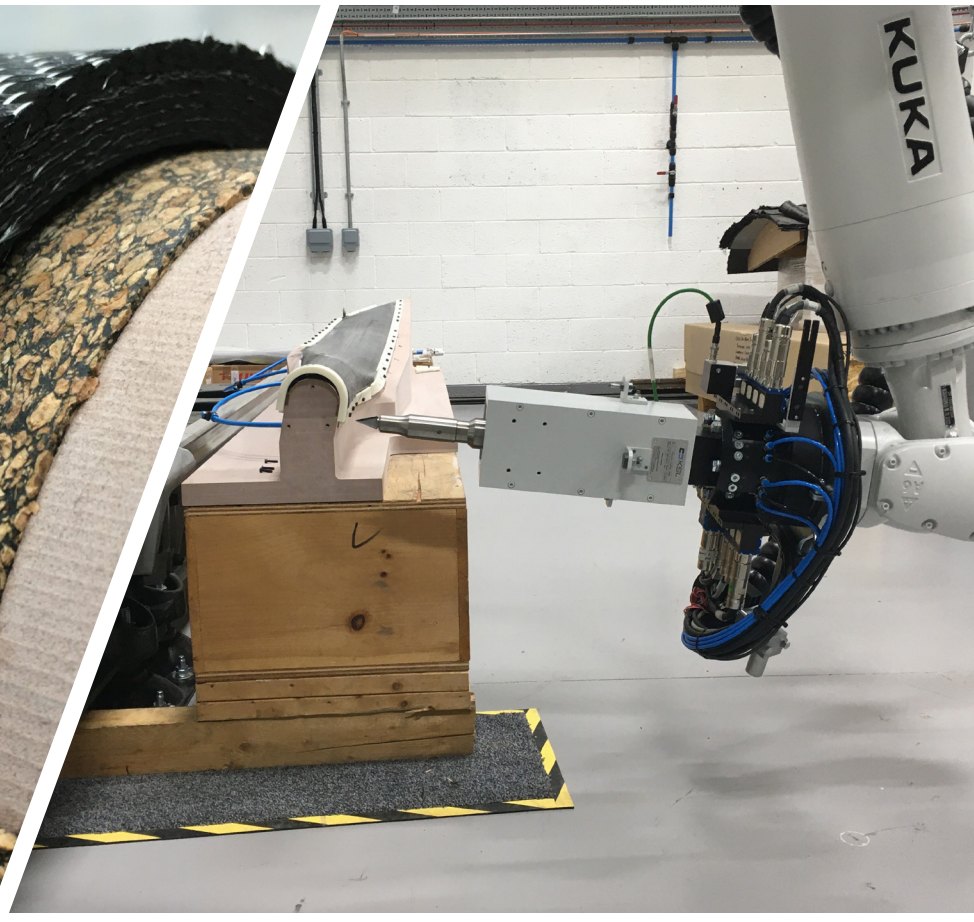
AMRC Technology Development: Ultrasonic Trimming

Challenge

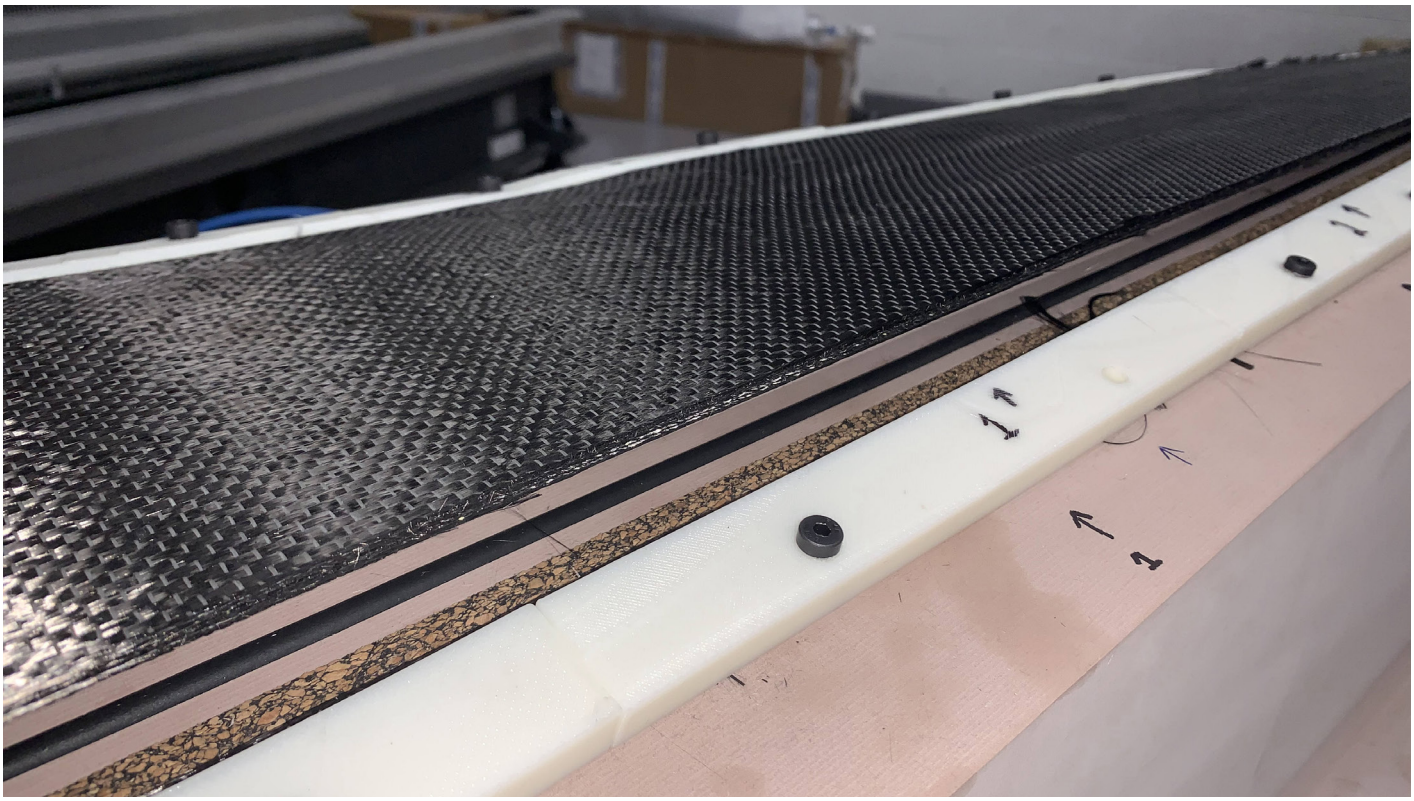
Demonstrate the feasibility of trimming 3D formed composite preforms to size using an ultrasonic knife mounted on a robot arm to support Dowty Propellers' flexible manufacturing capabilities of complex blade geometry for its next generation composite propeller blades.







CATAPULT High Value Manufacturing

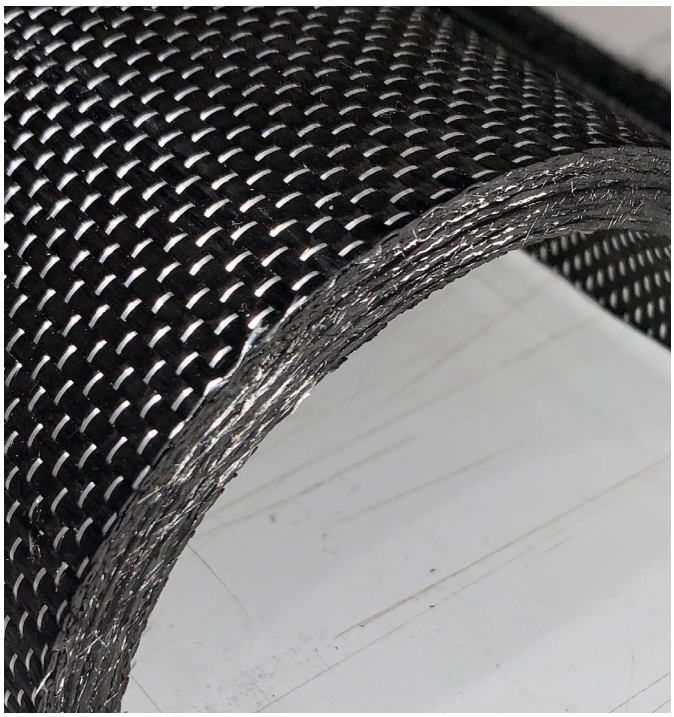


Trimmed part edge following initial cutting trial.

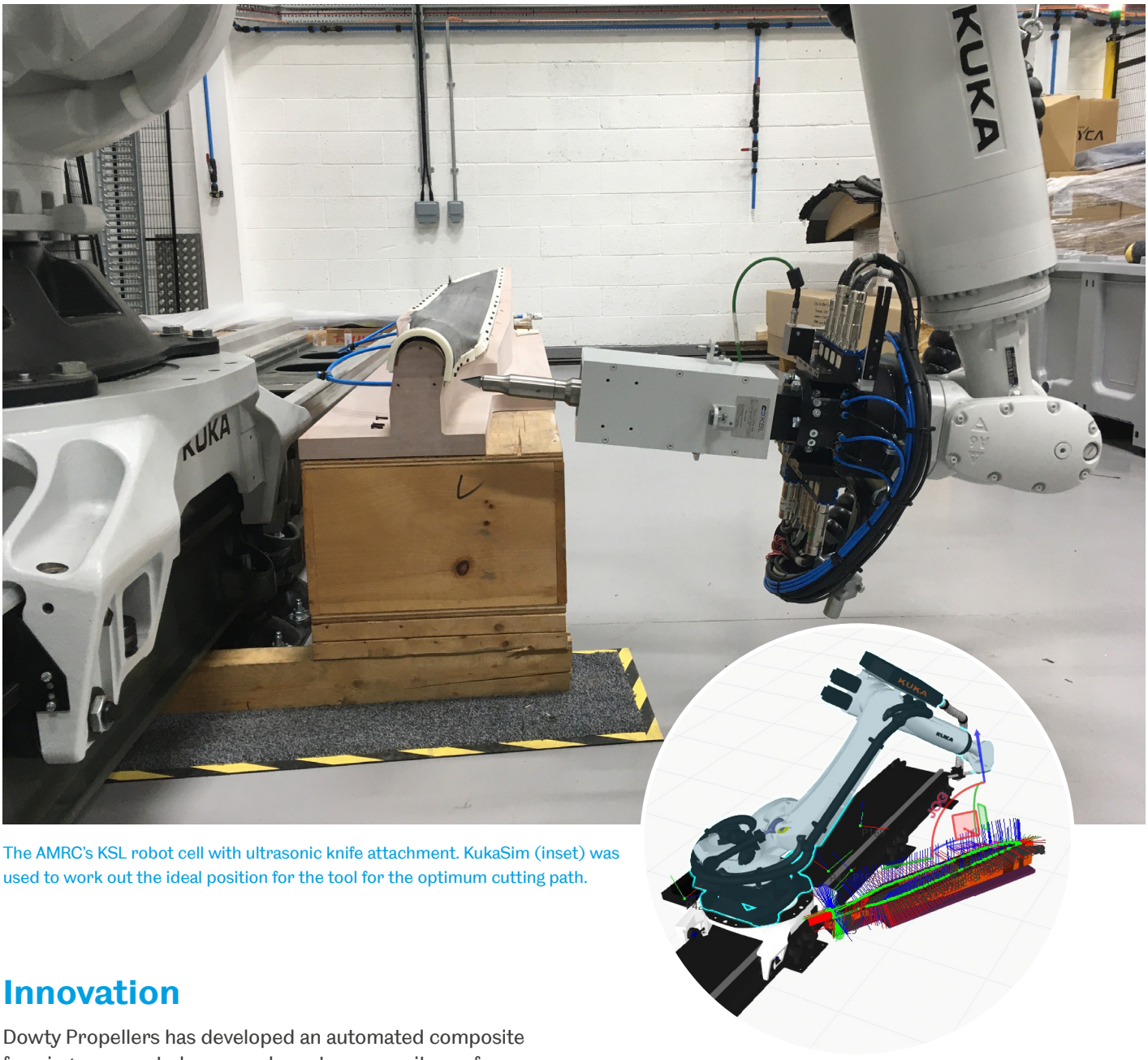
Background

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, 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.



Propeller blade edge showing high quality trimmed surface.



The AMRC's KSL robot cell with ultrasonic knife attachment. KukaSim (inset) was used to work out the ideal position for the tool for the optimum cutting path.

Innovation

Dowty Propellers has developed an automated composite forming process to lay-up and create composite preforms used in the manufacture of various propeller blades. Before assembly these preforms need to be trimmed to size to ensure a good fit in the Resin Transfer Moulding tool.

The aim for the AMRC Composite Centre was to demonstrate the feasibility of stitching stacks of material prior to forming into shape and the subsequent trimming to size using an ultrasonic knife mounted on a robot arm. The benefits of this are multiple. It means that composite ply stacks are stabilised in an efficient way for automated forming; the edge quality of the part is improved; the ultrasonic cutting process can handle multiaxial cutting requirements; complex geometry can be created; and, ultimately, the process is rapid and automatable.

The AMRC's work in the DigiProp programme focused on the preform holding and tool design, and the programming of a robot to follow the desired cutting path. This was the first commercial use of robotic ultrasonic trimming capability within the AMRC. Trials were first conducted on a Bullmer 2D ply cutter and the learning transferred to a KSL 3D robotic system capable of cutting complex geometry shapes with precision and very high quality.

Result

Through the DigiProp programme, the AMRC Composite Centre has been able to push the boundaries of what is capable with composite manufacturing. With reduced cutting time and improved quality of parts, the team were able to prove ultrasonic trimming as a viable technology that has application for other sectors. Results included:

- Very high quality trimmed parts being produced;
- A reduction in cutting time from ten minutes to two minutes following development trials;
- Able to cut complex shapes, internal pockets and chamfered edges;
- Links with a suite of preforming and dry fibre technologies available at the AMRC.

Impact

The ultrasonic trimming work undertaken as part of the DigiProp programme was very successful and proved that in addition to use for 2D woven preforms, it can also be used for both braided and 3D woven preforms. This capability is under further development at the AMRC.

As well as having applications for propeller blade manufacture, the ultrasonic trimming process can be used to support the automotive sector with near-net shape preforms, working with the AMRC's bespoke High-Pressure Resin Transfer Moulding system which is the most advanced within a UK research institution.

The ultrasonic knife was able to produce chamfered cuts (left) and complex pocket shapes (right) with high accuracy.

For further information please contact Chris McHugh:

0114 222 1747 | c.mchugh@amrc.co.uk | amrc.co.uk