SAMULET II P1 - Tighter Specification Aerofoils

Rolls-Royce (Lead), University of Sheffield (AMRC), Advanced Forging and Forming Research Centre (AFRC)

Project details:
To remain competitive and meet the requirements of future engines, there is a constant and growing need to develop new and innovative manufacturing technologies that improve the accuracy and precision of aerofoil components, enabling significant improvements in airflow in the gas turbine engine, resulting in Specific Fuel Consumption (SFC) improvements.

This project was a collaboration between Rolls-Royce, the AMRC and AFRC that touched on a wide range of technologies and operated across different work packages. The project aim was to develop new manufacturing processes that enable cost competitive manufacture of advanced aerofoil designs which rotate at high speeds and efficiently compress the incoming air. These included: new forging methods; optimised machining; improvements to the Superplastic Forming (SPF) process. The project aimed to achieve 30% improvement in productivity, 100% Right First Time (RFT), and significantly reduced process cycle times.

Table 1: Summary of the project grant details

Project	Funding	Lead Partner	No. of Partners	Partner Composition	Duration
110100 Tighter Specification Aerofoils	Total: £5.8m Grant: £2.9m	Rolls-Royce	3	1 Large company, 2 Catapults	April 2012-Dec 2015

Table 2: Summary of the project focus areas

ATI Value Streams		ATI Enablers		ATI Attributes		Strategic Horizon	
Whole Aircraft		Aerodynamics		Safety		Secure	X
Structures		Manufacturing	X	Cost	X	Exploit	
Propulsion	X	Materials		Environment	X	Position	
Systems		Infrastructure		Fuel Burn	X		
		Process and Tools	X	Operational Needs			
				Passenger Experience			

Technology Achievements:

SAMULET II Project One incorporated multiple new tooling and machining technologies, and novel processes to produce great improvements in forging high temperature aerospace materials, including significantly increased die life and accuracy of finished components. Improvements and development of new form tools, when combined with static and dynamic vibration monitoring have reduced the amount of operations to manufacture both the Front Bearing Housing (FBH) and Rear Outer Casting (ROC) from 10 to 6. This resulted in a reduction in overall cycle time for the FBH by 39%, and machining time for the ROC by 35%.

There have been significant improvements in the Super Plastic Forming process with the creation of complex 3-dimensional modelling to significantly increase process understanding, leading to a reduction in tooling costs, validation costs, and new product introduction lead time. These improvements when combined with the development of an improved Boron Nitride coating have enabled 60% improvement in die life with resultant increase in time between die changeovers and a 25% reduction in the SPF cycle time on full scale fan blades.

Compressor Blade Forging

Table 3: Summary of the technology achievements

Project	Performance Improvements	TRL Progression
110100 Tighter Specification Aerofoils	- Reduce SPF cycle time by 25% - Improve die life by 60% for SPF process - Reduce aerofoil machining time by 30% - Reduced rear outer casing machining time by 35%	TRL 2 - 6

Economic Impact:

As a result of the tighter specification aerofoils project, Rolls-Royce has purchased over £4m of capital equipment for aerofoil machining / forging in the Inchinnan facility and super plastic forming in the Barnoldswick facility.

- Many of the technologies developed in this project will be deployed in the new facility in Barnoldswick where Rolls-Royce is investing over £28m for a wide chord fan blade facility extension, with the design of the cells and the purchase of capital equipment being heavily influenced by the technology advancements in this project, ensuring manufacture of tighter tolerance aerofoils components in the UK for many years to come.
- This will provide a significant level of workload on the SMEs and local suppliers to provide tooling, fixtures, dies and materials to support the manufacturing processes in the Inchinnan and Barnoldswick facilities. This will have the additional benefit of raising the technology capability of the Rolls-Royce factories and the local SMEs, making them more competitive and increasing the opportunity for future business.

Table 4: Summary of the economic impact

Project	Value created	Employment
110100 Tighter Specification Aerofoils	Over £4m of capital investment	Jobs Safeguarded: 15

Next Steps:

Rolls-Royce will incorporate the new Super Plastic Forming technologies onto all future SPF blades produced at Barnoldswick, with an opportunity to apply this technology onto legacy components.

Rolls-Royce is planning to capture all of the learning in the aerofoil machining work-package, the front bearing housing work-package and the SPF work-package on a software system termed the 'Rolls-Royce Commodity Desktop'. This is a knowledge management system for engineering and manufacturing data. It is accessible, via the standard computing platform, by all engineers and technologists in the United Kingdom and is designed as a 'first port of call' to ensure that best practice and learning is adopted and deployed in future work.

The first exploitation of the tighter specification aerofoils technologies developed in this project will be in the Trent 1000 and XWB.

"Rolls-Royce, working in conjunction with the Research Centres has overcome significant technical challenges to develop technologies that offer tighter specification aerofoils, helping to significantly improve future aerofoil manufacture at our Inchinnan and Barnoldswick facilities."

Steve Burgess, Director, Manufacturing Technology, Rolls-Royce

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