The University Of Sheffield.
Advanced Manufacturing Research Centre
BOEING

T900 Combustion Casings Project

Background

The T900 combustion casing is part of a Rolls-Royce gas turbine power plant.

The casing has to be made from a very difficult to machine heat resistant super alloy, to ensure it maintains its strength and hardness while being subjected to very high operating temperatures.

In 2006 the AMRC began a project in conjunction with Rolls-Royce to apply advanced machining techniques, tooling and strategies to the casing, with the aim of developing new technologies that would reduce manufacturing time and costs, while maintaining, or increasing, quality.

Innovative fixturing solutions were developed during the project, on which the AMRC now holds world-wide patents. Novel tool-path strategies, using state of the art tooling, were applied to the component, taking the technology from a basic principle to an application now seen as industry best practice, both for Rolls-Royce and its global supply chain.

Project deliverables

- Innovative fixture design and basic production concept.
- Raised the MCRL of various tooling strategies and applications such that they are now rated as having been proved in a production environment on production equipment at production rates.
- An improvement in the CAD/CAM capability of the AMRC with respect to component type.
- Applied in process, on machine verification of dimensional target conformance, at the machine controller.
- Significant reductions in the machining time associated with producing this type of component.

Technology detail

Heat Resistant Super Alloys (HRSAs) have been commonplace in the aerospace industry for many years, especially in gas turbine combustion systems. HRSAs are incredibly difficult to machine, because of their high hardness and strength at elevated temperatures. Modern demands, driven by the need to reduce operating costs, emissions etc, mean HRSAs have had to become increasingly harder and stronger at elevated temperatures, making them even more difficult to machine. The AMRC has been able to develop ceramic milling techniques which achieve metal removal rates far in excess of conventional milling techniques.

The heat resistant properties of ceramic inserts, their high hardness and the mechanical properties of the work piece allow far higher cutting parameters to be used than are possible with conventional machining with carbide inserts. These cutting parameters equate to a very high volume of metal removed per minute (cm^3/min = Q) - more than 10 times higher than conventional machining strategies.

A higher Q value can vastly reduce the time spent machining, which has a huge cost benefit to manufacturers.

The AMRC has pioneered the application of this milling technique and is now looking at further refining the process. Our understanding of ceramic milling allows us to reliably estimate typical insert life for given parameters on a given HRSA material. We have also benchmarked the cost of ceramic milling against more convention methods to ensure the overall process reduces tooling costs, as well as manufacturing time. OEM methods of tool path manipulation have been independently tested and verified and industry 'best practice' established which has been rolled out to world leading manufacturers of the combustion casings. In some cases, this has led to them completely redesigning manufacturing methods.

Research into the dynamic interaction between ceramic inserts and components is continuing in a bid to establish the same understanding as exists for carbide inserts. Optical measurements are also under way, linking the size, shape and intensity of the sparks emitted from the tool to the wear and hence remaining useable life of the insert. This should allow the AMRC to define process KPV's fully and introduce a complete scientific optimisation strategy, based on our research.