Automated process planning to minimise unit cost using feature based design and genetic algorithm optimisation

UTC for Computational Engineering

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Introduction

Rolls-Royce is aware of the benefit of improving the consideration of manufacturing cost, in addition to their performance capabilities, on its products, as it is the overall value of its product which will attract customers.

In line with SILOET (Strategic Investment in Low-Carbon Engine Technology) 2.5.2 this project focusses on a methodology (based around codified knowledge) which takes a parameterised design and creates a cost optimised manufacturing route so the designer can see the cost implications of their design decisions.
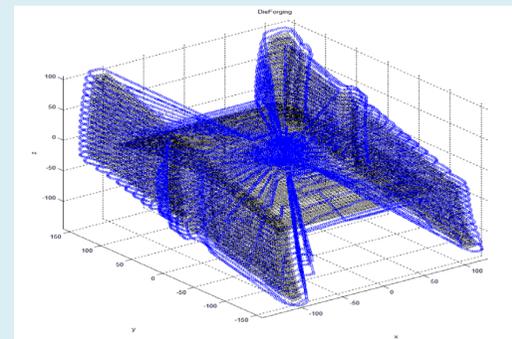
Manufacturing Optimisation

The first part of this research focusses on creation of the shape which will be created by the manufacturing strategy chosen.

The second focusses on creation of the manufacturing route. This is done by identifying which processes can be used as a final machining process for each feature, then using backward and forward propagation to get a set of manufacturing processes. The manufacturing sets for each feature are then combined and rearranged (subject to feasibility constraints) to give the optimal manufacturing route for the component.

Finally the chosen manufacturing route must be evaluated for cost the manufacturing route must be optimised. Thought should be given to maintainability of the methodology and system created.

Figure 1: A near representation of a Rolls-Royce component used for this project

Knowledge of the precursor shape

A key question in the determination of manufacturing costs is: What is the precursor shape created by an additive process? A tool has been designed to answer this question in two and three dimensional geometry.
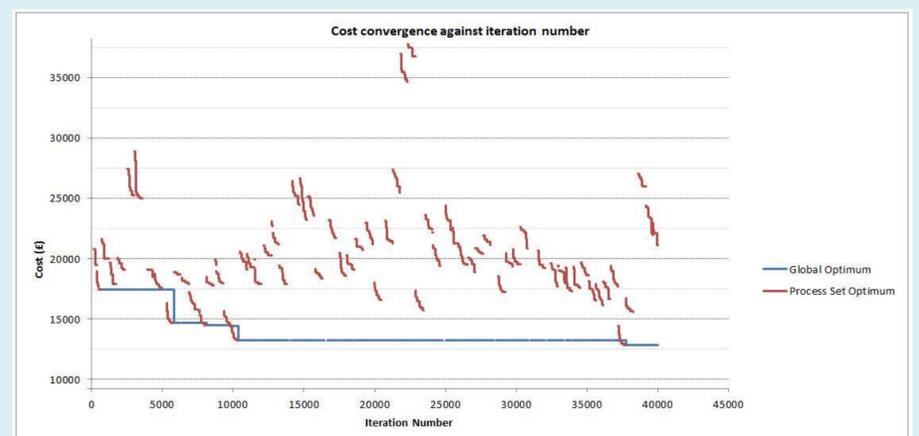

And for axis-symmetric shapes...

Finished Part   FoSCo Result
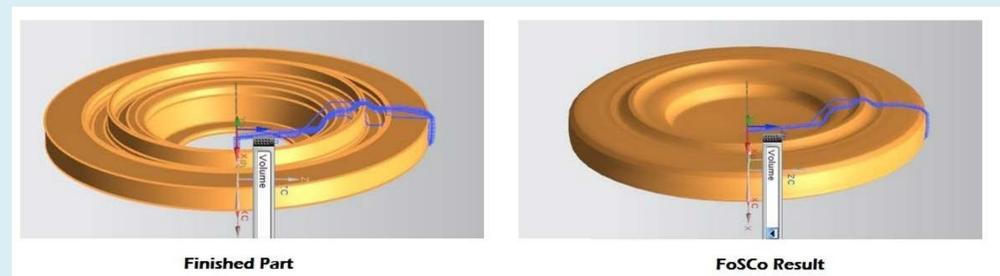
Optimiser Convergence

The optimiser for the choice of manufacturing processes is a random mutation hill climber. For each iteration of this algorithm an integrated optimiser for the sequencing is run. The convergence of both optimisers is shown below.

Summary

A prototype software solution has been created based on the methodology which is finding the global cost optimum (with almost certain probability, for a simple test case) in less than a minute. Feedback from the primary customer has been positive.

Final Viva Stuart

4 slides
- Hypothesis
- Method
- Results
- Summary

Poster should be the same