

## Automated Generation of Manufacturing Routes and Cost Evaluation for Unit Cost Reduction

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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. During the design process this recognition is created using integrated design teams which include manufacturing experts. This is not always an ideal solution so this project was instigated to create alternative methodologies for cost evaluation during the design stages.

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.

In addition the methodology allows 'what if' analysis for the potential introduction of new manufacturing technologies by asking the question 'would manufacturing process x be beneficial from a cost perspective if it were available'.

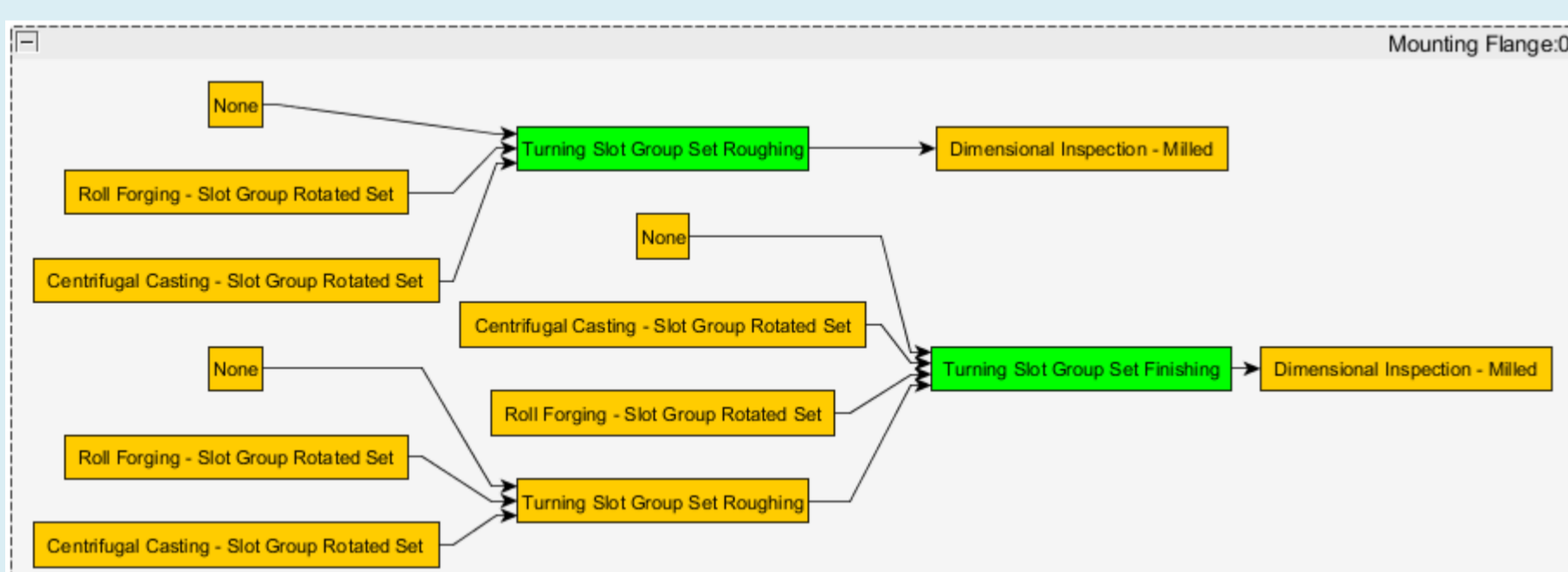


Figure 1: An example process possibilities map for a manufacturing feature

### Cost Evaluation

The second part focusses on the evaluation of the route created. For each manufacturing operation the cost is calculated. This is broken down into different categories, they include the equipment cost for the time taken, labour cost, tooling cost, material cost etc. each cost is calculated using functions stored in the central database of knowledge. These functions can contain numerical values associated with the feature, numerical values associated with the part and constants. It is intended that for currently used processes the manufacturing owner of a given process will aid in population of the functions, for a novel process the best guess of the pre-production owner would be used.

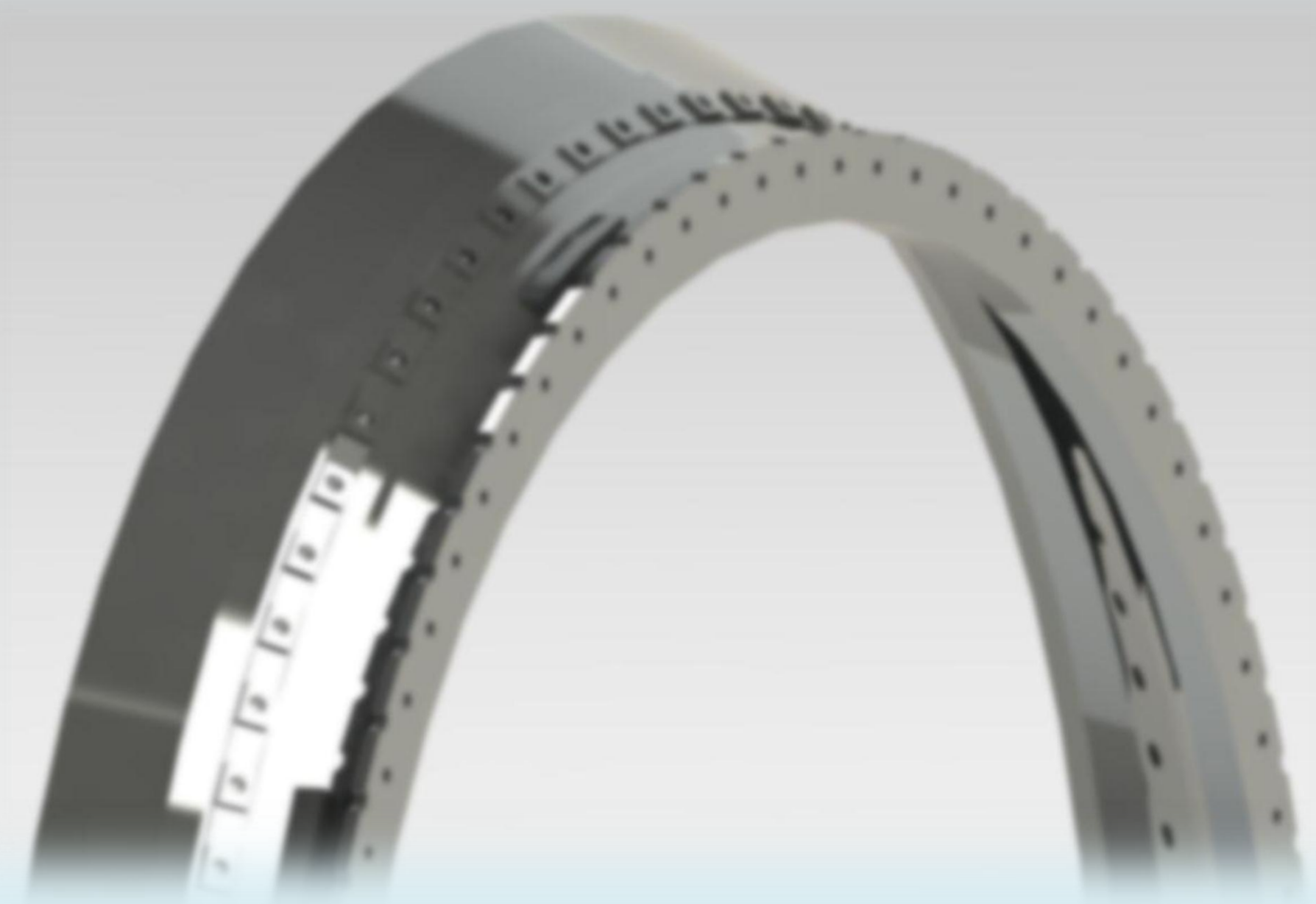


Figure 2: A near representation of a Rolls-Royce component used for this project

### Manufacturing Optimisation

The first part of this research 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 constraints) to give the manufacturing route for the component.

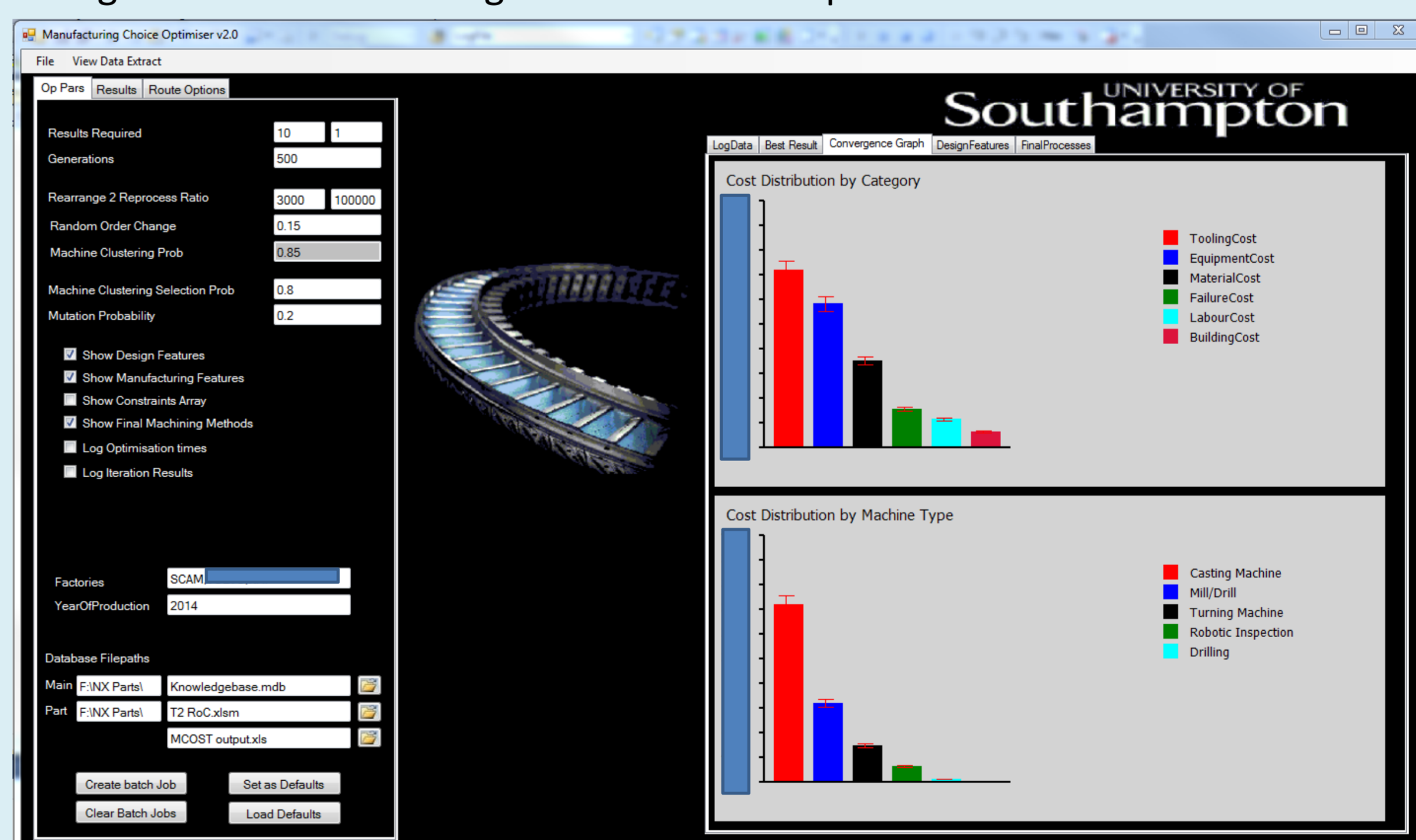


Figure 3: Example of results page of test case 2 optimisation (not Rolls-Royce part or data)

### Summary

A prototype software solution has been created based on the methodology which is finding the global cost optimum (with a 40% probability, for a simple test case) in less than a minute. Feedback from the primary customer has been positive and primary customer trials are intended shortly.