Value Driven Design

UTC for Computational Engineering

Julie Cheung and Jim Scanlan: CEDG School of Engineering Sciences | Dr. Steve Wiseall: Rolls-Royce plc

UNIVERSITY OF Southampton
School of Engineering Sciences

What is Value Driven Design?

The importance of cost is now well established in the transport industry, in particular within the commercial aerospace companies such as Rolls-Royce plc. Their technology and the performance of the products are extremely sophisticated; therefore the competitive factor between the aerospace companies is increasingly based on cost. Customers are demanding lower cost products without sacrificing their requirements. An alternative interpretation of Value Driven Design is Design to Cost. A substantial portion of a product's cost is dictated by decisions on its design. This highlights the significance of treating cost as an independent design parameter that can be controlled during the development cycle. Traditionally, cost tended to be considered late in the development cycle, which could lead to high costs if the designs were to change. There is now a shift to establish and understand cost drivers throughout the design phase, particularly when design and manufacturing options are considered.

Aim and Objectives

This research aims to support the concept of 'Designing Future Generation Gas Turbines to not only meet Performance Targets but also to meet Cost Targets.' A viable route is to influence Rolls-Royce plc design and manufacturing engineers to become aware of costs that directly drive the choice of design solutions and manufacturing processes. This approach is assisted through exploration of case studies that build on the idea of integrating the cost parameter at early stages of design. The outcome of this research will be a delivery of tools/techniques and knowledge to support design decision making. This forms part of the Cost Modelling Strategy being developed in the Research and Technology Cost Engineering team at Rolls-Royce plc.

Novel Component Cost Modelling

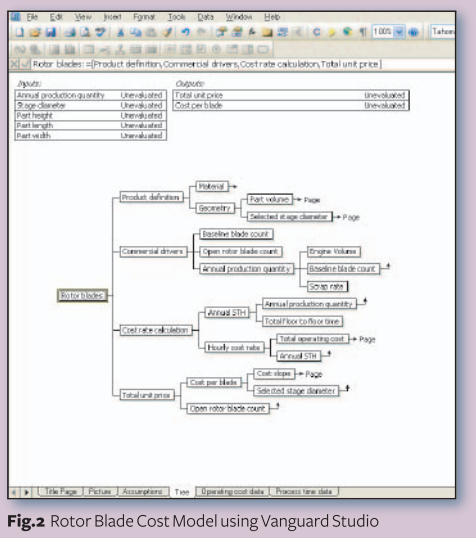

Fig.2 Rotor Blade Cost Model using Vanguard Studio

One of the case studies being examined is to build cost models for novel components. The models will allow engineers or designers to understand the cost drivers in developing the component. The unit cost is modelled which includes recurring costs i.e. operating costs. The software selected for this study is Vanguard Studio, which has been well established as a costing tool at the University of Southampton and has been integrated into Rolls-Royce plc. The European project **DREAM** (vali**D**ation of **R**adical **E**ngine **A**rchitecture syste**M**s) led by Rolls-Royce plc is developing contra-rotating open rotors (See example **Fig. 1**) as one of their project themes. It is known that open rotors reduce fuel burn by 10%-15%, which is an attractive feature given today's environmental concerns.

Fig.1 Example of Open Rotor Engine Configuration

A high-level cost model of the rotor blades (**Fig. 2**) has been developed. The model is driven by general design parameters and existing processes since little information is readily available at the early design phase. Sensitivity analysis can be performed in Vanguard Studio to establish which of the design or process variables are the main cost drivers. The need to simulate a virtual factory of a new process has been identified to generate realistic cost rates. A potential tool for this application is ExtendSim. It provides the environment and tools to model a process and can be integrated into Vanguard Studio. An example of the user interface is shown in **Fig. 3**.

Data Mining for Cost Estimation

An alternative approach to estimate cost is using data mining methods. Existing design and cost data of various engines and their components are entered into a large database. By exploring methods and techniques used in data mining, relationships between design attributes can be established to estimate the cost of a new engine design. A powerful data mining tool is STATISTICA Data Miner by StatSoft. The tool offers a user-friendly interface (**Fig. 4**) and has a comprehensive selection of data mining procedures and graphical functions to aid analysis (**Fig. 5**).

Future Work

The models in the Novel Component Cost Modelling case study will be refined as more design and manufacturing process information becomes available, as with the virtual factory model. The issue of uncertainty of data will be addressed as well as design complexity. The integration of the factory model into Vanguard Studio will also be tested and implemented. Further research will be applied to the Data Mining case study to test pilot ideas for an engine cost estimation tool. The methods and techniques used in data mining can be adopted by a third case study that considers Whole Engine System Design and integrating a cost parameter into a design tool e.g. Unigraphics to allow preliminary designers to visualise the impact of varying design parameters on cost.

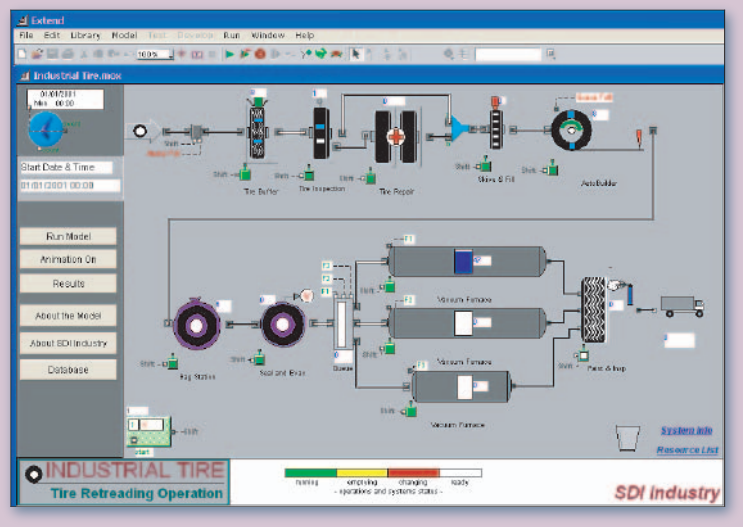

Fig.3 Sample of a Tyre Manufacturing Process Modelled in ExtendSim

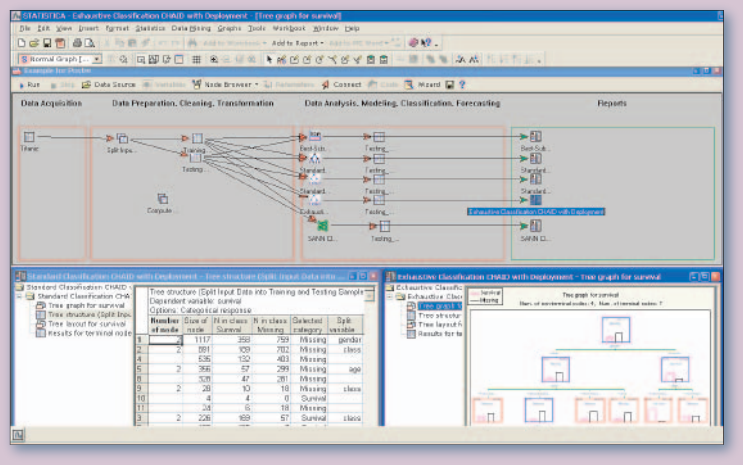

Fig.4 STATISTICA Data Miner User Interface

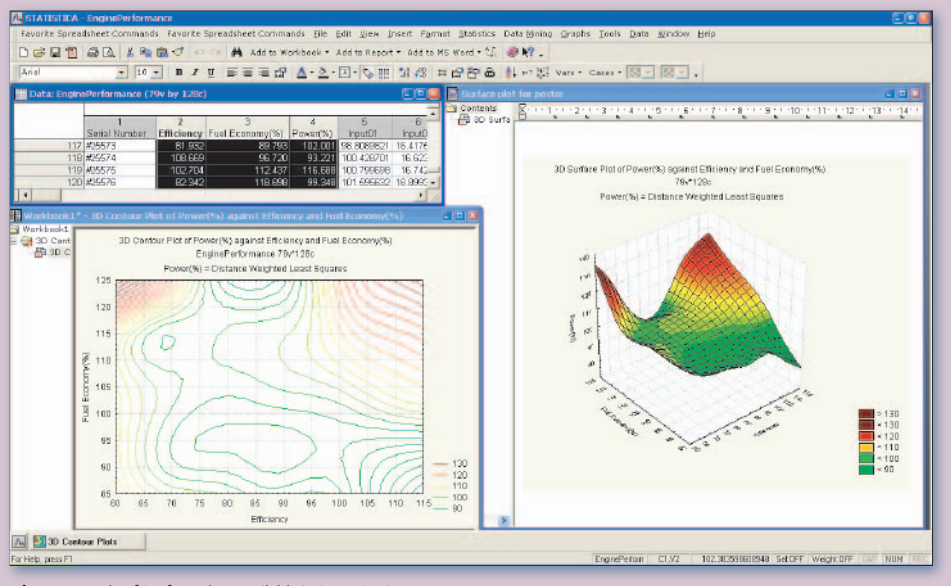

Fig.5 Example of Surface Plots available in STATISTICA

Acknowledgements:
This work is part of the author's Engineering Doctorate (EngD) at University of Southampton, sponsored by Rolls-Royce plc and EPSRC.

www.soton.ac.uk/ses/research/ced/posters.html | email: Julie.Cheung@soton.ac.uk
Steve.Wiseall@Rolls-Royce.com

Computational Engineering & Design Group, University of Southampton, SO17 1BJ, U.K
R & T Cost Engineering, Rolls-Royce plc. PO Box 31. Derby, DE24 8BJ