



# Rolls-Royce

**Client:** Rolls-Royce

**Assignment:** Enabling Robust Design

## World Leading by Design

### Background

Most areas of manufacturing are facing dramatic changes in market forces. Those like Rolls-Royce, who are at the leading edge of technological advancement, are facing more changes than most.

The gas turbine market is at the forefront of the debate on climate change as politicians and consumers seek to balance the demand for increased air travel with the need to cut carbon emissions. Aero engine manufacturers like Rolls-Royce, General Electric and Pratt and Whitney have been improving the performance and emission of their latest engines by at least 1% a year for the last 10 years or more.

Pressure to accelerate the performance and lower the emission of aero engines, combined with intense competition in the market and a shift from engine and parts provision to one of total care, has had profound implications for aero engine design and manufacture. Performance needs to be balanced with ease of maintenance, longevity of service, robust design and continuous upgrade. For over 100 years, Rolls-Royce has responded to this challenge by continuously building on its pedigree of engineering excellence. In developing and implementing their *Robust Design* process, utilising and further refining standard design approaches such as Design for Six Sigma (DfSS), Rolls-Royce is better able to design in robustness, performance and reliability from the outset and largely avoid the need to take the more standard, time consuming and costly quality "tested in" approach.

### **The need**

Rolls-Royce are well aware that maintaining a lead in the highly advanced and competitive aero engine market requires a highly skilled workforce combined with the ability to adopt and refine proven design methodologies, tools and techniques. They are also aware that these methodologies, tools and techniques are only of value if they translate into products that provide them with a commercial advantage in the marketplace. Bourton Group were approached and asked to assist them in getting “to the next level” in their utilisation and further refinement of robust design using DfSS. For the last five years we have been working closely with Rolls-Royce, providing technical training for its designers, analysts, and management whilst also helping them refine, improve and apply DfSS to enhance their ability to remain at the forefront of aero engine design and manufacture.

### **Our most recent work**

This most recent phase of activity built on Rolls-Royce’s wider programme of continually “up skilling its workforce in order to maintain its commercial and technological lead in the market”. Whilst Rolls-Royce management has been the commercial force, Bourton had been the training and technical force, working globally with design teams across its Civil, Defence, Energy and Marine Divisions for the last five years.

The aims and objectives for this particular programme were:

- Train and support intact design teams to apply the DfSS method through a complete design cycle in a way that would realise additional tangible and demonstrable benefits.
- Codify the new tools and techniques in a common global design methodology that could be implemented across all business streams.
- Stimulate the organic growth of “robust design” as the standard way of working within the design community by providing thought leadership and through continuous development of highly skilled internal mentors - experts in DfSS application and the DfSS equivalent of Master Black Belts.

The first step was to set up a pilot programme with six IPTs (Integrated Project Teams) to thoroughly test the programme and provide a base of expertise for scaling up the programme at a later date. The aim was to ensure that the IPTs had all the skills needed to implement a refined design process that had its roots in the specific DCOV (Define – Characterise – Optimise- Verify) approach to Design for Six Sigma. The approach was tailored to Rolls-Royce’s specific engineering environment by aligning the DCOV approach with RR-specific engineering tools and their core “gated” engineering process. It quickly demonstrated benefits by dramatically increasing the fidelity of designs within a similar design time and cost envelope and solving some previous intractable engineering problems. The systematic approach also aided in rapid deployment and successful embedding within the business. Ultimately, this enhances speed to market, cuts development costs and reduces costly in-service design modifications.

### **Roll-Out**

With the pilot phase completed, 30-40 DfSS mentors were then trained, supported by a hard core of subject experts from across the design, analytical, management and engineering disciplines. The roll-out was bottom-up, demand-led, with IPTs from across the business signing up for the programme. Although this was a tougher and slower adoption process than a top-down mandatory one would have been, the programme took hold. Those undertaking the training and adopting the DCOV approach did so because they believed in the approach rather than it being mandated. Rolls-Royce management understood the culture and motivation of their design community and realised that DCOV had to prove itself to gain widespread adoption.

Bourton was the Six Sigma thought leader for Rolls-Royce, developing a comprehensive mentor development and certification system as well as delivering “deep dive” technical training as required. The success of the pilot and subsequent roll-out has led to the development of awareness courses for managers to assist the spread of the robust design programme up the organisation and the establishment of local Champions to take pressure off the central team, ensure sustainability and minimise constraints on the pace of implementation.

### **Value delivered**

Engineering failures in aero engines or other gas turbine applications are extremely serious matters resulting in unwanted downtime, costly fixes and potentially loss of life. By adopting robust design, Rolls-Royce is dramatically reducing the number and impact of these failures. Early indications show that this approach is having the desired effect (£20m to date) with preventative benefits of the order of £100m per annum targeted.