

2.3 Thermo-mechanical Analysis of a Turbine Disc

Presenting Institution: Rolls-Royce PLC.



Rolls-Royce

Problem Presenter: Ron Bates, Cath Kindred

Abstract (Technical Topics and Desired Outcomes): In modern turbo-machinery, robustness to uncertain operating conditions, as well as geometrical and material variability is vital for performance and operational lifetimes.

Objectives: This Use Case concentrates on an adapted Rolls-Royce training example designed to assess the effect of component temperature distributions, stresses, tip clearance etc. on changes to model geometry, material and boundary conditions. The simulation is either a combined transient thermo-mechanical analysis or a thermal analysis followed by a series of single time point stress analyses using interpolated temperature distributions.

The model has been devised to represent a simple gas turbine spool. A single stage drilled rim high-pressure turbine, linked to a 3-stage axial compressor drum is assumed, with an internal cooling air system. As well as boundary conditions representing heat transfer coefficients, mass flows, and heat pick-up terms - a dozen or so - the Use Case aims to investigate the effect of component geometry with hundreds of user defined parameters.

UQ&M Aspirations: The UQ&M objective is to propagate the uncertainty on various input parameters (conceivably many hundreds) through the model to assess their impact on performance. There are benchmark results for some performance measures based on Monte Carlo analysis. The idea would be to contrast these with other methods. Key questions:

- How does variation in the boundary conditions affect the temperature at the rim (blue star in Fig. 4)? This value (and variation) affects the life of the disc.

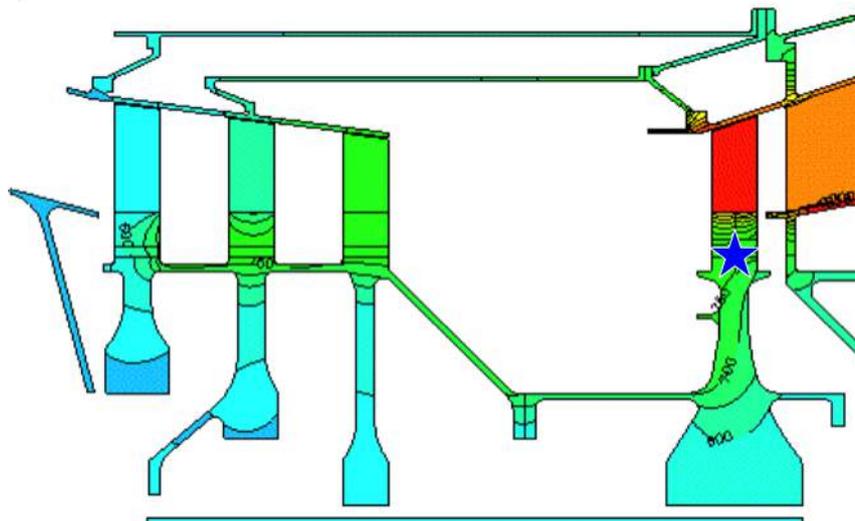


Figure 4: Simplified 2D Model and Rim Assessment Location

- What methods exist to examine the (potentially) very high dimensional problem the geometry / material variables introduce.
- What effect do 3D features have on the simplified model

Resources Available for this Problem:

- A 3D parametric model representing a simple gas turbine spool.
- Engineering experts from Rolls-Royce able to run the workflow (described above)
- Data on input uncertainties based on performance decks

References:

1. Full problem details can be found here: [Thermo-mechanical Analysis of a Turbine Disc](#). A presentation will be given on the first morning of the Study Group.