TOPOLOGY OPTIMISATION OF HIGH PRESSURE TURBINE BLADE TIPS

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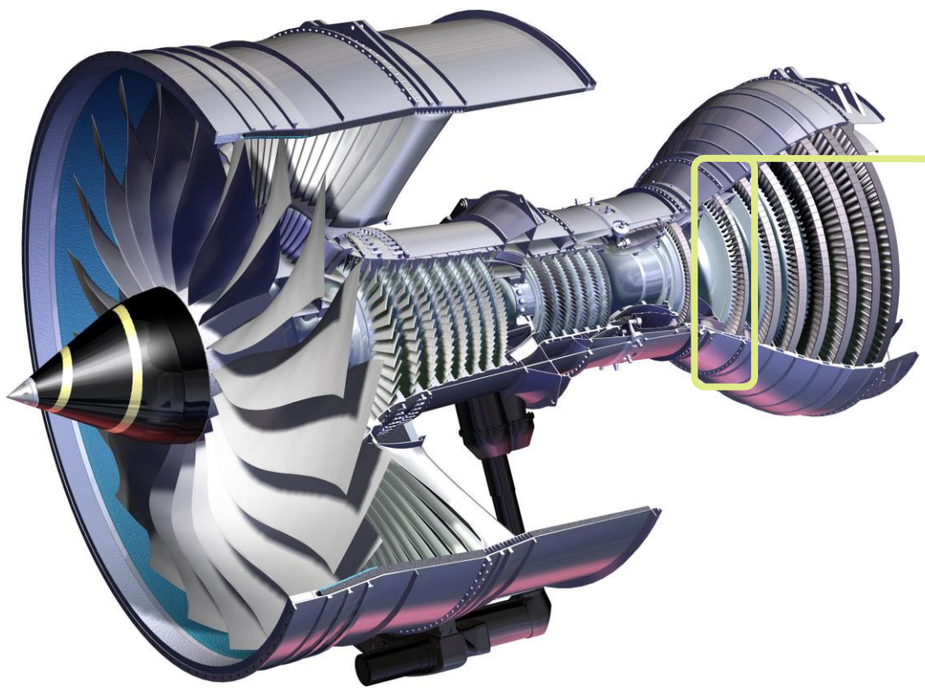
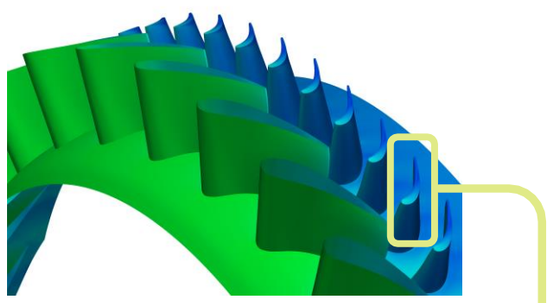
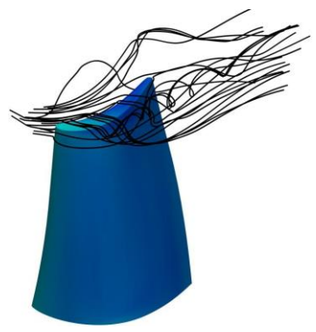


Rolls-Royce jet engine



High pressure turbine



Rotor blade – over tip leakage flow

CFD SIMULATION

- Computational Fluid Dynamics
- Insight of the flow details
- Predicts turbine performance
- Detailed evaluation of new designs

OVER TIP LEAKAGE FLOW

- Hot combustion gas drives the turbine
- Leakage flow over blade tip due to the pressure gradient in physical gap between stationary and rotating components
- Using leakage flow as pneumatic seal

MOTIVATION

- Increase of efficiency and power output
- Reduction of jet engine fuel consumption and emissions
- Better reliability and lower maintenance costs

PROJECT AIM

Use of complex flow physics models → Novel geometry investigation methods → Improved turbine blade design and jet engine performance

OPTIMISATION

Datum blade

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Creating new blade geometry using contoured 3D surfaces

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Analysis of blade performance with Computational Fluid Dynamics model

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Optimiser searches for better performing design

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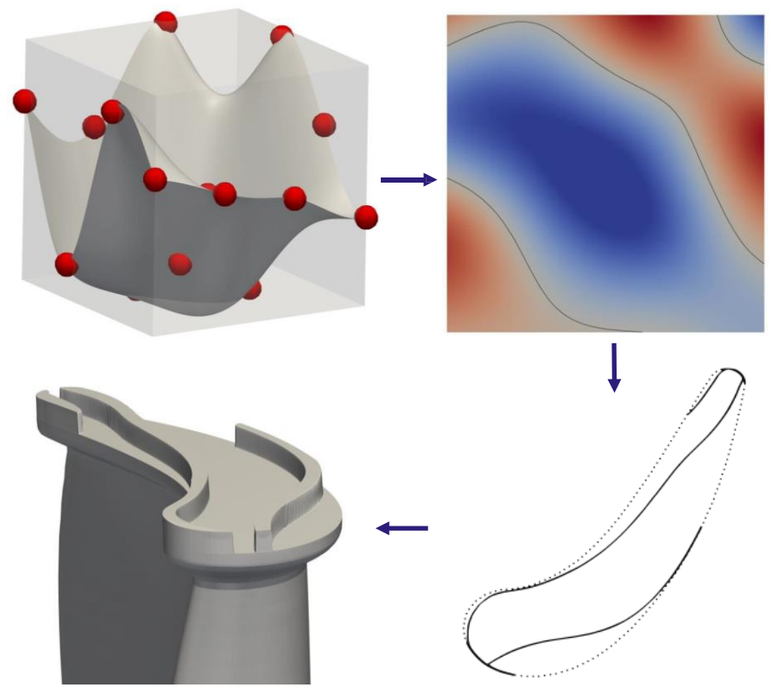
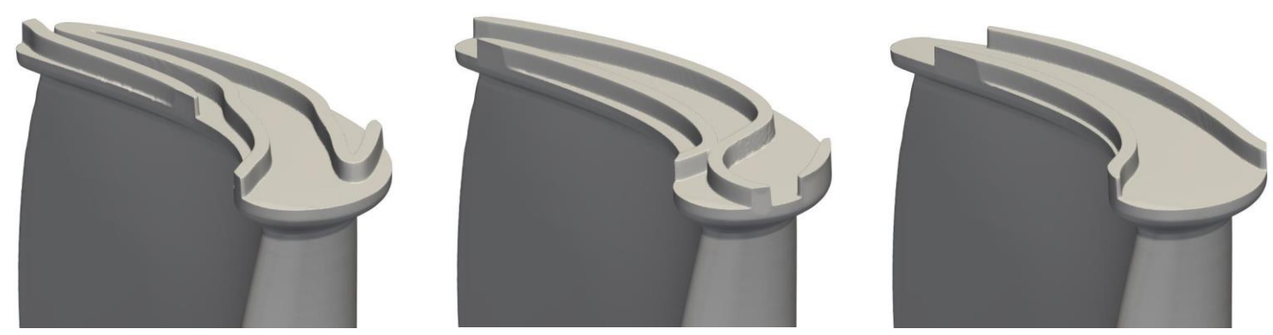
Optimised design



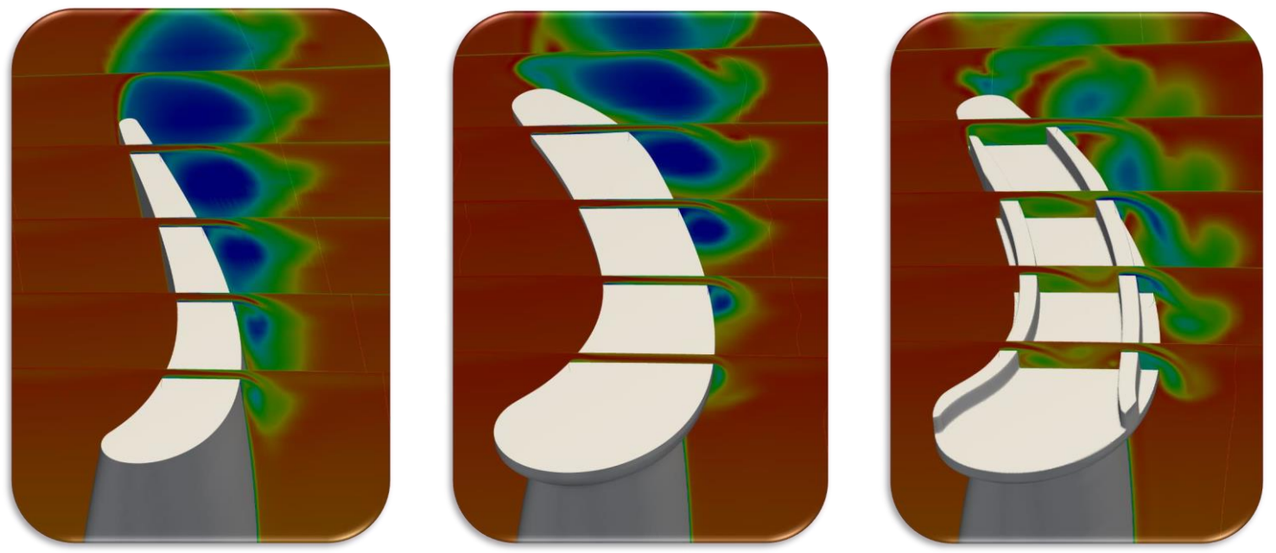
RESULT – NOVEL BLADE TOPOLOGIES

- Novel blade designs produced using flexible design space
- Gaps between tip ridges create sealing effect
- Reduction of over tip mass flow and less dissipation
- Significant efficiency improvements
- Demonstrates the power of topology optimisation when using novel definition of design space



IMPACT

- Turbine efficiency increase through the use of pneumatic seal effect
- Novel definition of turbine blade geometry for quick exploration of design approaches
- Novel blade design for improved engine performance
- Proposing both design and the method for high pressure turbines
- Expanding the optimisation methods to multiple disciplines such as blade cooling and manufacturing processes
- Towards state of the art design for new generation of Rolls-Royce jet engines



Datum tip | Optimised tip #1 | Optimised tip #2

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