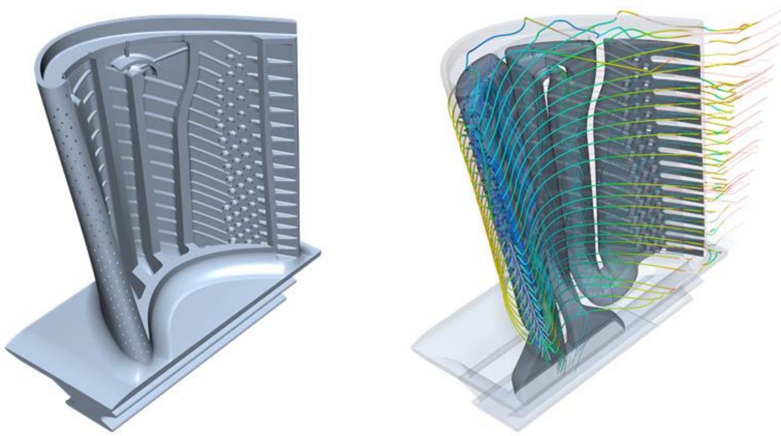
QUB - Mechanical and Aerospace Engineering PhD Project
2019-2020

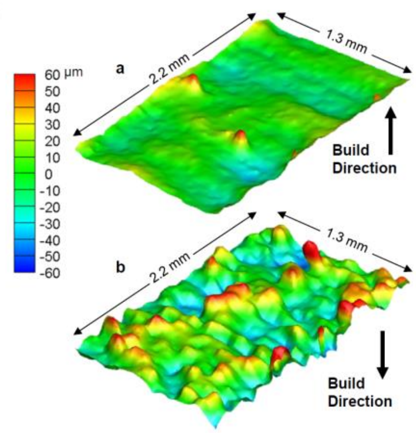
Title: Innovative design capability of turbine blade using additive manufacturing

Project description:

Manufacturing turbine blades with a conventional approach requires additional processes due to complex geometries, which could be eliminated if all features are produced in the same process; this will be an innovative manufacturing. Fully integrated functional devices, not just individual piece-parts, can be produced in one build, as the additive manufacturing (AM) technology permits the consolidation and functional integration of parts. Functional integration of parts reduces the number of parts, thus reducing the challenges encountered during the assembly process. The increased design freedom by AM will enable **more efficient and effective designs of turbine blades** that will ultimately lead to further increases in overall gas turbine engine efficiency. However, AM results in significant inherent surface roughness on turbine blades. Developing the understanding and predictability of aerothermal behaviour for AM surface roughness is clearly required.



<Gas turbine blade cooling system and CFD simulation>



<Roughness of AM surfaces>

The synergetic behaviour of AM with optimal design is another advantage. Design optimization is a powerful design approach to save time, material and energy. For gas turbine engine components, there are mostly extreme requirements that lead to very complex part geometries, as aerothermal performance increases with complexity. AM technology provides the designer with greater design freedom and facilitates the production of complex part topology that cannot be produced with the conventional manufacturing techniques. Therefore, design optimization can be used to reduce the weight of engine parts, by modifying their topology and exploiting/controlling surface roughness, while maintaining their functional requirements and improving their performance.

Aims and Objectives:

In this project, the **aerothermal behaviours in additively manufactured key turbine components will be characterised through numerical and experimental tests**. Furthermore, **the development of innovative and effective design parameters** and correlations between the aerothermal characteristics and AM surface roughness will allow a turbine designer to make good use of surface roughness to produce more innovative designs.

The successful outcome of the project will contribute towards advancing a new generation of more efficient propulsion technologies through the opportunity of providing better understanding of aerothermal behaviour in additively manufactured turbine components, as well as appropriate and effective design parameters exploiting AM surface roughness for more innovative turbine blade designs.

Key skills required for the post:

Undergraduate degree in Mechanical Engineering, Aerospace Engineering or equivalent academic discipline, with good achievement in Fluid Mechanics or Aerodynamics, Thermodynamics and Math.
Good communication skills; the candidate will be expected to develop good quality technical papers for publication in journals and presentation at peer-reviewed international conferences.

- Desirable: Previous experience on 3D CAD modelling, CFD, or Optimization algorithm

Key transferable skills that will be developed during the PhD:

The candidate will use the following advanced modelling packages:
ANSYS CFX/FLUENT and/or OpenFOAM for CFD
ANSYS Mechanical for FEA
CATIA or SoliWorks for 3D solid modelling
MATLAB and/or C++ for Optimization algorithm
These skills are highly relevant to energy, aerospace and transport industries.

The following generic skills will be developed: Interrogation of technical papers and patent literature. Confidence in technical presentation and writing, to present your ideas and influence others. Network of contacts to assist future career development.

PhD students in the Turbomachinery Research Group are expected to participate in the international technical community by attending international conferences in North America, Europe and Asia. It is also expected that high quality technical papers will be presented by the student at the leading conferences – ASME Turbo Expo, the Global Power and Propulsion Forum and the European Turbomachinery Conference.

Lead supervisor:	Dr Sung in Kim (s.kim@qub.ac.uk)
Other supervisor(s):	Dr Yasser Mahmoudi-Larimi
Guaranteed stipend:	£15,009 per annum
Conditional top-up available:	A performance related top-up of up to £3,000 per annum is available.

PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.