QUB - Mechanical and Aerospace Engineering PhD Project 2019-2020

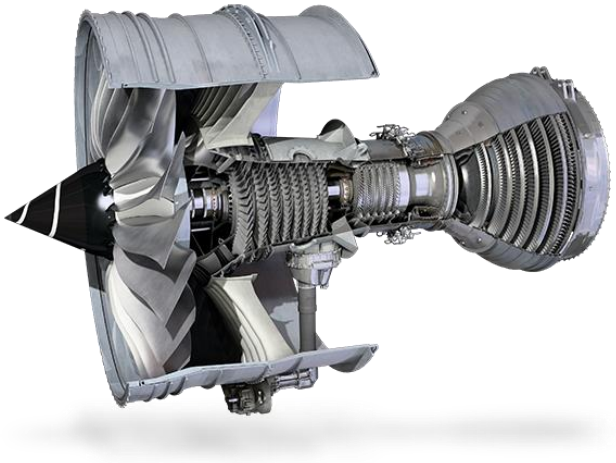
Title:

Fan Modelling for Aerodynamically Coupled Simulations

Project Background and Objectives:

Over the past thirty years, computational fluid dynamics has come to dominate the design process in the aerospace industry. From power plants to fighter jets, the use of CFD is ubiquitous. Many of these tools are deeply embedded in the work flows of manufacturers, and, as such, accurate and fast tools are vitally important both environmentally and economically.

The accurate modelling of turbulence remains the last great unsolved problem of classical physics, and the tools currently in use can only be relied upon to be accurate in small, experimentally validated areas of the design space. This necessarily limits and slows the adoption of novel and potentially revolutionary designs – since the predicted physics cannot be assumed accurate. With the increase in computational power, however, new, but hugely more expensive, methods of turbulence modelling have become available, such as Large Eddy Simulation and Detached Eddy Simulation.



A major problem that companies in the field of aerospace design – such as Rolls-Royce, Mitsubishi, Siemens, or GE – have when designing jet engines is the fact that the flows around different parts of the engine influence each other both upstream and downstream. This is particularly problematic around the intake, where the engine fan influences the flow around the intake lip, but the intake lip also influences the flow around the fan. This coupling can have major implications for engine performance, particularly at take-off. Strongly coupled problems such as this are notoriously difficult to capture computationally, as they massively increase the cost of the simulations. When using higher fidelity turbulence modelling, such as LES, this cost increase can be prohibitive, and mean that the calculations are not able to be carried out within the design timeframe – preventing the adoption of novel designs, and ultimately limiting the performance of the engine.

This project would build substantially on previous research into low cost models for fan performance, including both the implementation and the development of integrated models for loss, diffusion, and aerodynamic blockage, with the aim of producing a transport equation based low cost model that is capable of capturing the key flow features for both upstream and downstream coupling. This project would involve international collaboration with researchers at institutions in India, China, and the UK.

Key skills required for the post: A minimum degree of a 1st or a high 2:1 (or equivalent) in one of the following areas is required: Engineering, Science, IT, Mathematics or a closely related subject area. Solid computer skills are essential as the project will involve significant computer modelling, simulations and analyses, and it would be desirable if the candidate had some experience of working with computer code, such as Matlab, as there will be a proportion of development as part of the project. It would also be desirable if the candidate has some knowledge of the basics of turbomachinery,	
Key transferable skills that will be developed during the PhD: The key transferable skills that will be developed during this PhD project will be the development of high levels of experience and expertise in the use of CFD, the skills needed to successfully manage complex projects, international collaboration and networking, conference presentation skills, and software development ability.	
Lead supervisor:	Dr. Rob Watson, School of Mechanical & Aerospace Engineering r.watson@qub.ac.uk Tel:(+44) 02890974122
Other supervisor(s):	Prof. Stephen Spence, School of Mechanical & Aerospace Engineering Dr. Marco Geron, School of Mechanical & Aerospace Engineering
Guaranteed stipend:	Remuneration will include a basic stipend paid per annum, for which there may be a conditional top-up. The basic stipend for 2019/20 is estimated to be around £14,925.
Conditional top-up available:	The value of the top-up will depend on the candidate.
Demonstrator hours:	PhD students may also have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to £2,400 per year.
Enquiries:	For informal inquiries, email r.watson@qub.ac.uk
Closing Date for Applications	28th February 2019

Queen's 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.