Master Thesis - "Implementation of an inverse design framework for aerodynamic design of aircraft engine components" (30 credits/20 weeks – x2 students)

About us

GKN Aerospace is the world's leading multi-technology tier 1 aerospace supplier. With 55 manufacturing locations in 15 countries, we serve over 90% of the world's aircraft and engine manufacturers. We design and manufacture innovative smart aerospace systems and components. Our technologies are used in aircraft ranging from the most used civil aircraft to the world's advanced 5th generation fighter aircraft and the Ariane orbital rockets used by ESA.

Project Background

Background

Traditional "direct" aerospace design methodologies revolve around defining a geometrical shape, computing the aerodynamic performance of this shape and then analysing and usually re-designing the shape until the outcome meets a given set of criteria (say a suitable pressure profile). Inverse design routines invert this process by first defining the preferred outcome of the design process first (say the preferred pressure profile), and then performing a inverse design process to generate the geometry which results in these outcomes. That is for example, while in direct design, the pressure profile for an airfoil is the output of the design process, in the inverse approach, the preferred (usually optimized) pressure profile is an input. Using target aerodynamic profiles of pressure, loss and other quantities adds the advantage that these profiles can be designed and optimized ahead of time subject to constraints such as boundary layer thickness and shape factor, to provide the maximum possible aerodynamic performance for a component, for which the associated geometry can be generated. Recent work in the design of axisymmetric S- or Swan Neck diffuser ducts (SNDs) has shown that pre-designing an optimized pressure recovery profile can result in significantly shortened geometries, with high but robust performance across operating ranges, resulting in reductions in engine length and specific fuel consumption (SFC). Design of such a framework also has benefits for other components, such as struts and rotating / stationary blade rows, where highly performant airfoils can then be designed, whilst avoid costly separations and overly thickened boundary layers. The design and implementation of such a system has the potential to be integrated into a number of existing design tools at GKN Aerospace and therefore have wide ranging impact of the next generation of aerodynamic components for flying engines.

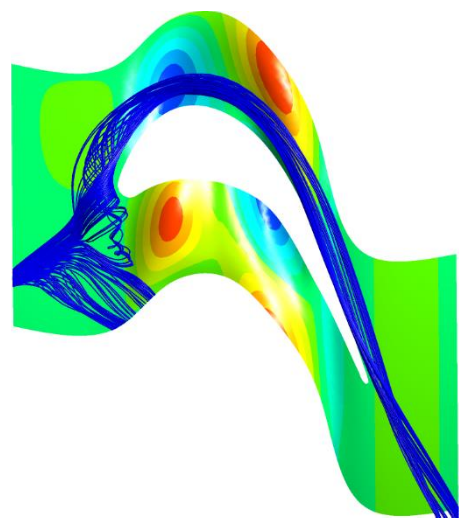

Figure 1 Secondary flow around optimized low pressure turbine end wall contours [1]

Assignment Description

This thesis involves the design of two components: implementation of a 1) a target profile design / optimization tool and 2) an inverse design capable of generating the geometry associated with the target profile. In particular, the implementations should be able to design highly optimized target profiles taking into account various constraints, but general enough to be applied to a variety of potential configurations (for example an axisymmetric duct or airfoil). To allow for ease of reuse as well as rapid development, the implementations should use the Python programming language and be well structured and documented. Suggested algorithms for such an implementation might be the modified Garabedian–Mcfadden (MGM) or Ball-spline algorithm.

Description

- Content and milestones
    - Review of the existing literature relating to inverse design procedures, boundary layer analysis and simulation methods

    - Review of applicable constraints which might apply to the given problem (prediction of boundary layer separation, flow turning in a Swan Neck duct)
    - Development of the target design profile generator
    - Implementation of a suitable inverse geometry design routine
- Deliverables
    - A technical report or similar detailing
        - Review of prior art in the inverse aerodynamic design space
        - Review of the fundamental aspects of the selected optimization and inverse design methodologies
        - Implementation and use of the main components of the inverse design framework
    - Presentation at GKN Aerospace

Qualifications

- Bachelors degree with a strong interest in aerodynamics and / or computational mechanics as well as coding (or the ability to learn to code) in Python
- Student(s) who are passionate about aerodynamics and want to make a difference to how aerodynamic components are designed.

Apply by

Send your resume and cover letter including a brief description of previous engineering experience or interests to **Jonathan Bergh** and / or **Blanka Tonsic** at jonathan.bergh@gknaerospace.com / blanka.tonsic@gknaerospace.com.

Last date for application: **As soon as possible**

References

[1] Bergh, J *et al* "Optimization of Non-Axisymmetric End Wall Contours for the Rotor of a Low Speed, 1 1/2 Stage Research Turbine With Unshrouded Blades." *ASME Turbo Expo 2012,* Copenhagen, Denmark. June 11–15, 2012. pp. 1153-1165. ASME.