Master Thesis – “Inverse finite element analysis for jet engine applications]” (30 credits/20 weeks – 1 student)

About us

GKN Aerospace is the world’s leading multi-technology tier 1 aerospace supplier. With 33 manufacturing locations in 12 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

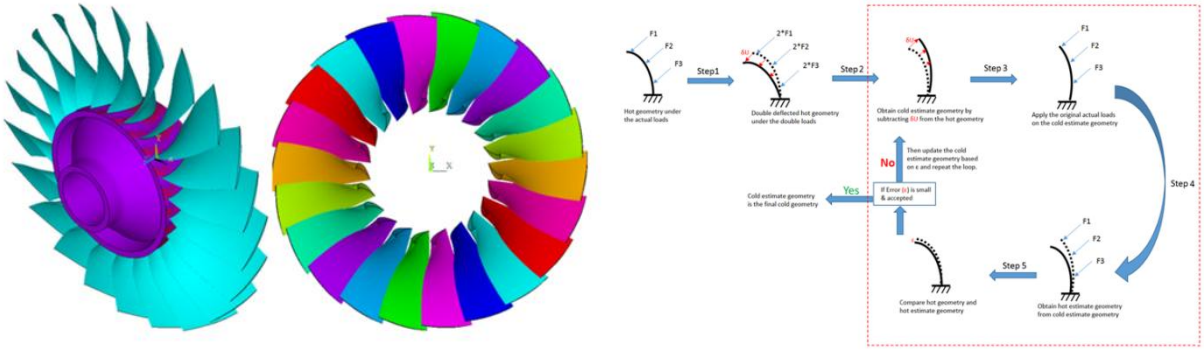


Fig 1: (left) NASA Rotor 67 (right) Analysis workflow including hot to cold conversion of the geometry [Image credits: Ansys]

A jet engine consists of several rotating parts, such as the blisks shown in Figure 1, as well as static components including casings, frames, and bearing houses. The structural analysis of these components typically begins with a geometry provided by the Aerodynamics department, which represents the component in its hot operating condition (Step 1 in Figure 1). The hot operating condition corresponds to the engine running under normal operating loads, where effects such as rotational speed, temperature, and pressure are already present. Applying loads on the hot geometry results in ‘double deflected’ state. However, manufacturing requires the corresponding cold geometry, that is, the unloaded shape which, when subjected to the operating loads, deforms into the target hot geometry.

Obtaining the cold geometry from the given hot geometry is currently achieved through an iterative approach, highlighted by the red box in Figure 1. In each iteration, the computed deformation is subtracted from the double-deformed geometry to generate an updated estimate of the cold geometry. The loads are then reapplied, and the resulting deformed shape is compared with the target hot geometry. The iterative approach can be computationally expensive and time-consuming.

Therefore, the objective of this master's thesis is to develop a methodology that reduces or eliminates the need for this iterative loop, by investigating the use of inverse Finite Element Analysis (inverse FEA) to directly determine the cold geometry from a known hot geometry and loading state. Such a

method could significantly reduce or eliminate the current iterative procedure while simultaneously providing stress and strain information.

Assignment Description

The work in this thesis will focus on performing inverse FEA on rotor blisk (disc and blade) and a stator casing in Ansys Workbench or APDL. Adopting a step-by-step approach, the inverse FEA approach will be compared to the in-house 'hot2cold' method for (i) rotor blade, (ii) rotor blisk, and then (iii) a stator casing. Comparison metrics include the relative differences in the 'cold state' geometry, stresses, and strains.

The following tasks are foreseen:

- Literature study on methodologies for inverse FEA.
- Inverse FEA implementation in Ansys Workbench or APDL.
- Analyze a blade only geometry with Ansys inverse FEA and compare with in-house 'hot2cold'.
- Analyze a blisk (blade and disk) geometry with Ansys inverse FEA and compare with in-house 'hot2cold'.
- Analyze a casing geometry with Ansys inverse FEA and compare with in-house 'hot2cold'.
- Document and explain advantages and potential issues with the inverse FEA approach.
- Write a report and present results to disseminate knowledge.

Qualifications

Student(s) in the final year of their M.Sc. studies in the field of Civil, Mechanical or Aerospace Engineering with an interest in Solid Mechanics. Previous experience of FE analysis (e.g. in Ansys) is an advantage.

Apply by

Send your resume and cover letter to

Ana-Mari Petrova, Ana-Mari.Petrova@gknaerospace.com
Ritukesh Bharali, Ritukesh.Bharali@gknaerospace.com

Last date for application: 2026-10-31. Interviews will be held continuously, and the position could be filled up prior to the last application date.