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MULTIDISCIPLINARY AERO-THERMO-STRUCTURAL DESIGN OPTIMIZATION OF A MODERN HIGH-PRESSURE TURBINE ROTOR

Mario Carta[1], Tiziano Ghisu[1], Roberto Putzu[1], Shahrokh Shahpar[2]

[1] Department of Mechanical, Chemical and Materials Engineering, University of Cagliari
[2] Innovation Hub, Future Methods, Rolls-Royce plc

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In today's aero-engine manufacturing industry, the need for lower fuel consumption and higher thermodynamic cycle efficiencies has brought increasingly high turbine entry temperatures and mechanical stresses on the high-pressure turbine rotors. Optimized blade designs must achieve high aerodynamic efficiencies while maintaining acceptable levels of peak surface temperatures and structural stresses. This work presents the multi-disciplinary optimization of a modern commercial high-pressure turbine rotor geometry based on high-fidelity three-dimensional aerothermal (CFD) and structural (FEA) simulations using a set of Rolls-Royce proprietary numerical simulation tools. The main objective of this optimization is to maximize the isentropic efficiency of the high-pressure turbine stage while simultaneously minimizing the peak Von Mises stresses and peak near-wall gas temperatures on the rotor. The optimization is carried out by conducting an initial Design of Experiments (DoE) followed by the generation of three separate Response-Surface Models (RSM) using the open source GEMSEO optimization suite.