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Multidisciplinary Design Optimization of an Aero-Engine Fan Blade with Consideration of Bypass and Core Performance

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Abstract

A multidisciplinary and multiobjective optimization of a transonic fan blade for a high bypass ratio turbofan engine is presented including aerodynamic as well as structural static and dynamic performance criteria. The optimization strategy applied is based on a two-level approach consisting of a Differential Evolution algorithm coupled to a Kriging metamodel in order to speed up the optimization process. High-fidelity performance evaluations are carried out by means of 3D Computational Fluid Dynamics and Computational Structural Mechanics analysis tools. Multiple key operating points are considered in the optimization process; aerodynamic performance is evaluated at top-of-climb and cruise conditions, while maximum stresses are evaluated at take-off operation, taking into account centrifugal and gas loads. Blade vibration is furthermore assessed over the entire operating range. Aerodynamic performance is separately evaluated for core and bypass flows in order to match the requirements specified by the engine cycle design.

Keywords: Multidisciplinary Optimization, Fan Blade, Turbofan, Bypass Ratio, Aerostructural Optimization.