Multi-objective automated compressor optimization using a coupled CFD-FEM process chain

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ABSTRACT

The current presentation describes DLR's optimizer AutoOpti, the implementation of the metamodels "Kriging" and "Bayesian trained neural networks" as accelerating technique, and the process chain in the automated, multidisciplinary optimization of fans and compressors.
Two optimization examples are shown:

- A full stage performance map optimization of a highly loaded, transonic axial compressor.
- An aeromechanical optimization of a counter rotating fan

Methods and strategies for an aerodynamic CFD optimization coupled with a finite element analysis on the structural side are presented. The high number of free design parameters, a very limited number of CFD simulations, and conflicting demands both within the aerodynamic requirements and between the disciplines are a challenging optimization task. To navigate such a multi-dimensional search space, metamodels have successfully been used as accelerating technique.

In the first presented optimization four aerodynamic operating points at two rotational speeds are selected to achieve a required stability margin and optimizing the working line performance under this constraint. The investigated compressor concept is a highly loaded transonic stage with a single row rotor and a tandem stator, designed for a very high total pressure ratio.

In the second optimization example is about a multi-objective aerodynamic optimization of a counter rotating fan with mechanical constraints concerning the van Mises stresses in the blades.

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