Aeroacoustic Optimization of an Axial Fan with Variable Blade Loading

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The project aims to perform a multi-objective evolutionary optimization of an axial fan. The objective functions minimize noise generation and maximize the aerodynamic efficiency. The fan consists of seven individually shaped blades which are fitted with winglets and turbulators. This particular arrangement helps to reduce tonal noise.

The geometry of the blades is parameterized using the circumferentially averaged swirl and a corresponding solution of the Euler equations in Mathematica. The geometry of the winglets, the hub and the shroud is parameterized in the 3D-CAD Modeler of STAR-CCM+. For the evaluation of the objective functions, Large Eddy Simulations (LES) are carried out. The optimization is performed using a meta-model assisted NSGA-II algorithm. The final design of the axial fan is chosen from the resulting Pareto front.

Due to the large set of geometrical parameters, conventional aeroacoustic optimization strategies based purely on physical experiments may become tedious. However, the proposed algorithm helped to significantly accelerate the design process.

Author Company:
Ninsight
Author Name:
Michael Stadler, Michael Schmitz, Wolfgang Laufer, Peter Ragg
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