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BLENDER: AN AUTOMATED MESH MORPHING BLENDING TOOL TO EXTEND BLEND LIMITS FOR INSERTED BLADES AND BLADED ROTORS

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ABSTRACT

Blade blending is the process of removing and smoothing damaged sections of compressor and turbine blades. Blending changes both the aerodynamic efficiency, frequency response, and mode shape of the blade being modified. Given the narrow operating parameters of turbine engine machinery, particularly bladed rotors, tight blend limits on inserted blades and IBRs have been established to avoid intentionally mistuning a blade and causing response localization leading to high cycle fatigue. The goal of this research is to extend blend limits by providing a robust tool capable of simulating multiple blends on both finite element model as well as computational fluid dynamic meshes.

This paper presents an automated blend simulator tool designed to predict the effect of removing material from a blade at any position, orientation, or depth without CAD regeneration. Scallop blends can be described simply by their orientation, semi-major (length), semi-minor (depth), and fillet radius. As this is a CAD-less remeshing tool, multiple blends can be placed on the same mesh without the risk of model corruption to boolean errors. This tool will be able to predict both the frequency shift of a single blade due to the addition of a blend or blends as well as determine the increase in both the steady and vibrational stress for a variety of modes. The robustness of this tool depends on leveraging previous research, FEMORPH, but applied in a manner that does not rely on tessellated scan data from a blue light scanner unless used for verification of an actual blend. The approach presented will be experimentally validated by collecting free-free forced response results from a scanning laser vibrometer from an unblended and blended blade to demonstrate the accuracy of this tool as both an individual blade and fleet prediction tool.

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