The tip leakage flow in axial compressors is a significant factor in engine performance and a subject of investigation over the last several decades. Many studies have already shown that the vortices generated by this tip leakage can have a negative impact on the surrounding flow field and overall performance, and could potentially lead to excitations as well. This study examines the effect of these vortices on aeroelasticity, specifically, the effect of a circumferentially varying tip gap such as that produced by casing ovalization.

For this project, a single passage, structured grid, CFD model of a compressor’s mid-stage rotor-stator configuration was analyzed using StarCCM+'s harmonic balance solver with flutter motion. This was a frequency domain calculation, which provided significant time savings relative to a conventional time accurate approach. The vibratory results from an Abaqus model were incorporated into the CFD in order to calculate the unsteady aerodynamic work. The analysis modeled a circumferentially varying tip gap representative of what is seen in a real engine, and results were compared to solutions from models with circumferentially constant gaps. Furthermore, test data from an industrial gas turbine was utilized in order to recreate realistic levels of tip gap variation, as well as to validate the mechanical model’s vibratory results. The calculations showed that for the gap variation imposed, the instantaneous effects aligned with expectations; however, the variation from small and large gaps had a canceling effect on each other over the cycle of oscillation around the engine.

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Approved for distribution by Jayanta Kapat, Committee Chair, on March 24, 2016.

The public is welcome to attend.