Mistuning in bladed disk assemblies

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In the context of current aircraft turbomachinery, a complex mechanical design is required so that the engine withstands mechanically its working environment. In the case of the low pressure compressor rotors, this involves being able to support different loadings such as centrifugal forces, aerodynamic loads, vibrations, temperature effects… among others.

One of the mechanical design drivers is the structure vibratory phenomena, since rotors bladed disks are subjected to significant vibrations, which could eventually lead to structural failure. In addition, those vibrations are amplified when structural irregularities and random deviations appear in the bladed disk structural properties, that is, when the blades are no longer identical and the structure loses its cyclic symmetry. This phenomenon, called mistuning, is unavoidable in reality and it is caused by manufacturing tolerances, material properties deviations and non-uniform operational wears, among other factors.

Bladed disk mistuning is highly sensitive to structural properties from the ideally tuned case. Note that even small deviations cause drastically larger forced response levels and lead to spatial localization of the vibration energy in some blades. As a consequence, displacements and stresses soar, leading to high cycle fatigue and failure.

Being such an important phenomenon in turbomachinery design, mistuning is a matter of concern for Safran Aero Boosters, which has performed several mistuning studies regarding mistuning in low pressure compressors. Within this framework, this project investigates mistuning behaviour of several Safran Aero Boosters engines.