PhD in Mechanical Engineering

Research Title: Increasing Safety of turbine disk in Aerospace Engine" INSaNE

Funded by	Politecnico di Torino (Joint Research Projects with Top Universities)

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Context of the research activity	This project is carried out in close collaboration with the Samara National Research University, in Samara, Russian Federation (the partner University). The successful candidate will spend half of the PhD period, namely 18 months, in the partner University. In gas turbine engines deformation caused by vibrations must be reduced below a "reasonable" level to avoid failure of some components or of the whole engine. Despite the great advance in disk design, the problem of evaluating dynamic stresses at the design stage of gas turbine engines is currently an open issue. A common way to reduce dynamic stresses in turbine bladed disks is to include devices that add friction damping into the system. This additional damping reduces the vibration amplitude of the blade and consequently decreases the dynamic stresses. Dry friction is one of the most important sources of external damping in bladed disks. Unfortunately, frictional forces show a highly nonlinear behavior. This nonlinear behavior is emphasized when the normal contact load is variable, that is the typical condition in turbine engines. In this regard, reliable mathematical contact models are needed to determine the dynamic stresses in the bladed disks. These models must be sufficiently precise to simulate the energy dissipation effect during the operating conditions. The development of such models is a very important scientific and applied physic problem. Moreover, real disks cannot be simulated under cyclic symmetry conditions. Dimensional and geometrical tolerances and material non-uniformity introduce small variation on the sector geometry and mechanical properties that have a detrimental impact on the dynamic response of the disk. This phenomenon is known as "mistuning".

Objectives	The scientific objective of this joint project is to improve the accuracy in determining the dynamic response of the bladed disks and to advance engineer's capabilities in modelling mistuned disks with interfaces undergoing dry friction. The overall objective can be better explained with the following sub-objectives: • to create specific contact models that replicate the main physical phenomena at the contact interfaces with dry friction. In these models, the dynamics of the bladed disks will be considered for a single sector in cyclic symmetry condition. • To set up simplified contact models for the transition from the single sector to the full tuned bladed disks I presence of dry friction damping. In this first approximation, the model will linearize the (amplitude depending) contact stiffness and equivalent damping. • To develop dynamic models to determine the forced responses of mistuned the bladed disk with dry friction contact interfaces. • To validate the coupled problem between the mistuned bladed disk and interfaces with dry friction through experimental data.

Skills and competencies for the development of the activity	The successful candidate is highly interested in topics correlated to rotor dynamics, nonlinear dynamics and its correlation with dry friction contact. Essential skills are a very analytical mind, questioning and problem-solving capability. The successful candidate has proficiency in deeply investigate, theoretically and experimentally, a given problem. Good capability to accomplish an experimental job are needed. In detail, the candidate knows how to perform modal analysis and dynamic response. Important skills are an advance knowledge of commercial computational software (MATLAB), CAD software (SOLIDWORKS, CATIA, PROE) and finite element tools (ANSYS). Interpersonal skills are desirable.