Tutorial of basics - Blade/casing contacts in turbomachinery: state of the art and recent developments

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This tutorial of basics was initially planned to be part of the ASME Turbo Expo 2020 conference.

Objective

This tutorial aims at providing an overview of past and on-going research related to the field of rotor/stator interactions within turbomachines, with a focus on the blade tip/casing contact interface.

The growing significance of this interface in the design of modern aircraft engines and gas turbines has indeed motivated a vast amount of both applied and theoretical research work—in a variety of engineering domains—over the past decade. This tutorial also intends to detail practical outcomes of these works for manufacturers.

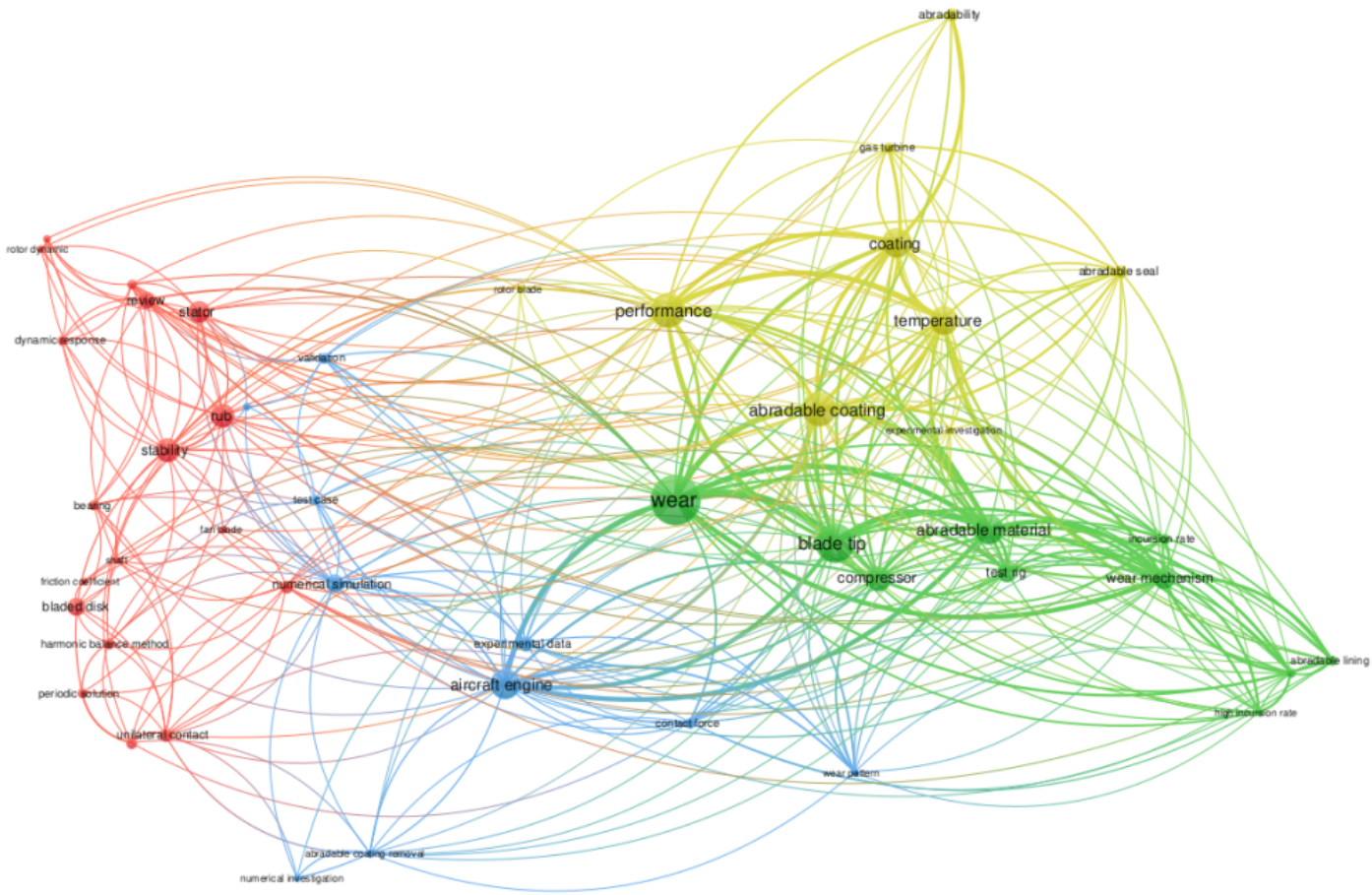
Abstract

The notion of rotor/stator interactions covers a wide variety of physical phenomena that are detrimental to aircraft engines operation. This tutorial focuses on rotor/stator interactions specifically related to the blade-tip/casing contact interface with an emphasis on structural dynamics considerations. The lack of a comprehensive theoretical framework for the analysis of mechanical systems featuring contact interfaces is a major issue for engineers and designers. They must prevent these interactions while ensuring a maximal efficiency of the engine with ad-hoc methodologies and often rely on empirical linear criteria. For this reason, the understanding and simulation of rotor/stator interactions subsequent to contact events have generated a large amount of research work over the past decade, both from a numerical and an experimental point of view. The extremely high cost for full scale experimental observations has motivated the design of simplified experimental setups as well as the development of predictive numerical tools. This tutorial will provide a brief overview of the main strategies employed by a variety of research teams worldwide to tackle this issue. In particular, a highly competitive context combined with

the analysis of proprietary bladed components has led to very distinct numerical strategies that are extremely difficult to compare. Various solution techniques, featuring distinct contact treatment algorithms with no standard benchmark make it almost impossible to compare numerical predictions from a publication to another. Accordingly, particular attention will be paid in this tutorial to give a detailed presentation of the state of the art in the field of rotor/stator interactions looking at various researchers' groundwork. The prediction of rotor/stator interactions could yield significant improvements for modern aircraft engines with great industrial implications, therefore, research on the prediction of rotor/stator interactions is still a much invested area in aerospace engineering. In this tutorial, on-going research topics of rotor/stator interactions as well as some of the most promising outcomes that are expected in a near future will be discussed.

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Visual representation of the bibliographic network of keywords of the referenced publications in the tutorial (source).

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