POST-DOCTORAL POSITION OPENING

"Wave propagation in curved variable-thickness structures: application to structural health monitoring of smart fan blades"

Laboratory and/or research group: PIMM / DYSCO Team

Supervisors and contact: Marc Rébillat (marc.rebillat@ensam.eu), Pierre Margerit (pierre.margerit@ensam.eu) and Nazih Mechbal (nazih.mechbal@ensam.eu):

Funding: EU H2020 MORPHO Project– Embedded Life-Cycle Management for Smart Multimaterials Structures: Application to Engine Components.

Starting date: 2nd semester 2022 **Duration**: 18-24 months

Context:

This PostDoc position is part of the H2020 project MORPHO where the overall goal is to enable efficient, profitable, and environmental-friendly manufacturing, maintenance, and recycling of next-generation smart engine fan blades. MORPHO consortium is built up with multiple partners across several European universities and companies and close collaboration with them is expected (see https://morpho-h2020.eu/).

The core body of fan blades is composed of bended and non-uniform 3D woven composite material, while the leading edge is made up of titanium (see Figure 1). These geometrically complex components are subject to **harsh environmental** and operational conditions, such as temperature, fatigue, vibration, and bird strikes. Hence, monitoring their **structural health** in a robust and automated way is an important challenge towards their development and exploitation.

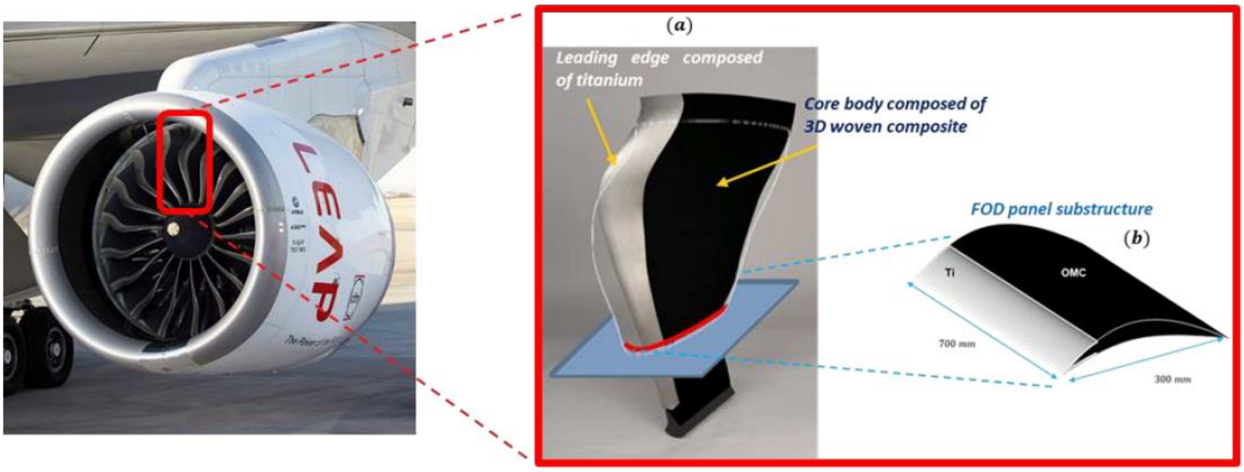

Figure 1: (a) Engine fan blades – hybrid material composed of 3D woven composite and titanium. (b). Foreign Object Damage (FOD) panel : a substructure extracted from the Fan blade.

Monitoring in real -time and autonomously the health state of aeronautic structures is referred to as Structural Health Monitoring (SHM). A SHM process is classically decomposed into four steps: damage detection, localization, classification, and quantification. In order to achieve this goal, the FOD panels will be equipped with **FBG** sensors that will be included during the RTM manufacturing process and with printed **PZT**. These sensors will provide the input data necessary to perform the SHM of the fan blades.

Objectives and research work:

The PostDoc candidate will be in charge of **understanding theoretically and experimentally waves propagation** and attenuation within a FOD panel and to then **propose a dedicated SHM approach** for such a structure that will be validated experimentally on a set of several (≃8) FOD panels manufactured by SAFRAN**.**

Among the **main objectives**, we can highlight the following:

- To perform a bibliographical review on **waves propagation in variable-thickness curved structures**.
- To develop **specific SHM algorithms from damage detection to RUL prediction** based on the previous understanding of the dynamical behavior of bended non-uniform structures.
- To validate the first two points through a **series of experimental campaigns** carried out on a set of representative FOD panels (≃ 10) manufactured by SAFRAN and equipped with FBG sensors and printed PZT sensors.
- **To collaborate closely with another PostDoc working on numerical reduced order models** of the dynamical behavior of the FOD panel that will be calibrated using experimental data.

Candidate profile

You are expected to hold a PhD degree in **Acoustics, Structural Dynamics or Ultrasounds** with an experimental background and a signal processing or machine learning component. We expect a demonstrable **interest and experience regarding both experimental and numerical or theoretical activities**.

Interested candidates should send to **M. Rébillat** (marc.rebillat@ensam.eu) and **P. Margerit** (pierre.margerit@ensam.eu) an application containing:

1) a **personal motivation letter** (max. 1 A4 page) describing why you apply and how the position fits into your career plans,
2) **a full CV** showing how your profile fits the requirements (max 4 pages),
3) an electronic copy of your **PhD's thesis**
4) **recommendation letter**s
5) a list of **referees** we can contact.

References:

"A general Bayesian framework for ellipse-based and hyperbola-based damage localization in anisotropic composite plates" C. Fendzi, N. Mechbal, M. Rebillat, M. Guskov & G. Coffignal. **Journal of Intelligent Material Systems and Structures** 27 (3), 350-374

"Damage localization in geometrically complex aeronautic structures using canonical polyadic decomposition of Lamb wave difference signal tensors" M. Rébillat & N Mechbal. **Structural Health Monitoring** 19 (1), 305-321

"Dichotomy property of dispersion equation of guided waves propagating in anisotropic composite plates" S. Guo, M. Rebillat & N Mechbal. **Mechanical Systems and Signal Processing** 164, 108212

"The high-resolution wavevector analysis for the characterization of the dynamic response of composite plates" P. Margerit, A. Lebée, J.F. Caron, K. Ege & X. Boutillon. **Journal of Sound and Vibration** 458, 177-196