PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DAADA-2025-07**
(à rappeler dans toute correspondance)

Lieu : Châtillon

Département/Dir./Serv. : DAAA/MSAE

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DESCRIPTION DU STAGE

Thématique(s) : Aéroélasticité

Type de stage : ☒ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

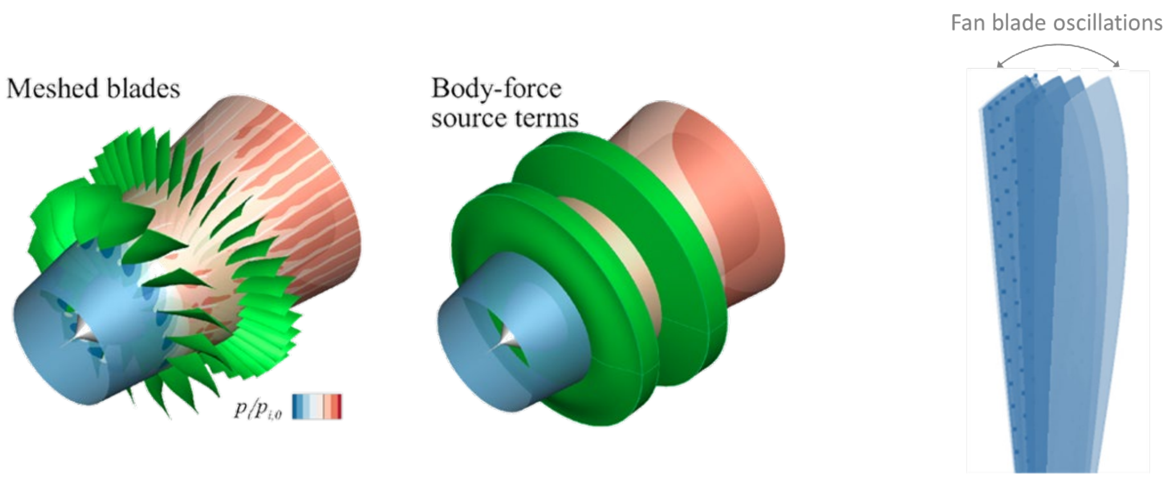
Intitulé : Mid-fidelity engine modeling method for aero-elastic investigation of innovative propulsion systems

Sujet :

The fan blades of future engine configurations will be subjected to significant fluid disturbances upstream of the fan disk (inlet distortions) for at least several phases of the flight envelope. This is the case for innovative engine integration architectures (BLI, distributed propulsion), the integration of unducted engines close to the airframe (open-fan architectures), or for turbofans featuring a small air inlet (UHBR engines). These inlet distortions impose aero-elastic constraints that need to be taken into account in the early design phases, and even in the optimization process. Indeed, the blade is subjected to cyclic loading, which can generate significant forces in the plane of the engine disk, or excite unstable modes of the structure.

In addition, these inlet distortions require the use of very costly high-fidelity numerical tools to study them (uRANS unsteady calculations), which is incompatible with an effective pre-design/optimization approach.

New, lower-fidelity modeling methods of the engine system are available to carry out such studies at a much lower cost. Among these, "body-force" methods, based on simple physical principles (thin airfoil theory, flate-plate boundary layer models, etc.), have already proved their ability to faithfully reproduce the effect of the engine system on the flow, and to capture the response of the structure to the inlet distortions. The goal of this internship is to continue this promising work, by attempting to increase the level of fidelity of these "body-force" methods and thus its ability to predict the unstable modes of the structure.



Left: Comparison of a turbofan aerodynamic study with conventional 'high-fidelity' and body-force CFD methods.
Right: Schematic of the oscillation of a blade when subject to an unsteady aerodynamic loading.

The candidate will benefit from an already functional Python environment to carry out his or her work. Initially, the aim will be to reproduce the results obtained in previous work on a transonic fan configuration subjected to BLI-alike distortion. The next step will consist in evaluating the influence of various additional models (shock loss model, viscous loss model and metal blockage model linked to the estimation of the turbulent boundary layer thickness) on the body-force's ability to accurately predict the distribution of forces on the blade and the main aerodynamic modes of excitation associated with air inlet distortion.

Next, the body-force method itself will be progressively modified in order to propose an unsteady formulation, the aim being to evaluate the gain in accuracy and set it against the extra cost involved. This work will enable us to assess the body-force ability to predict the forced motion of a fan blade, without and then with inlet distortions.

The skills required of the trainee are as follows:

- Good aerodynamic/CFD and structural skills
- Knowledge of the Python language, first project experience with this code is desirable
- Some notions of C/C++ will be useful at the end of the internship, depending on the trainee's appetite for programming.

Est-il possible d'envisager un travail en binôme ? Non

Méthodes à mettre en œuvre :

☐ Recherche théorique	☐ Travail de synthèse
☒ Recherche appliquée	☐ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : Non

Durée du stage : Minimum : 5 mois Maximum : 5 mois

Période souhaitée : printemps 2025

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	Ecoles ou établissements souhaités :
Master2, Engineer in aerodynamics/structure	ISAE, Centrale-Supélec, ECL, U Paris-Sorbonne, U Paris-Saclay, ENSMA