POST-DOC/RESEARCH ASSISTANT

Design and Off-Design Analysis of a Semi-Embedded Distributed-Propulsion Nacelle Concept.

Keywords: aerodynamic shape optimisation, body-force modelling, distributed propulsion

Department: Aerodynamics Energetics and Propulsion Department (DAEP)

JOB DESCRIPTION:

Hybrid-electric distributed propulsion concepts are being studied as potential subsonic commercial transport aircraft meeting aviation's long-term sustainability targets. One promising approach involves boundary layer ingestion (Fig. 1), which leads to a close coupling between the thruster performance and the external aerodynamics. This configuration offers the possibility of partially embedding thrusters in the airframe, and potentially housing all inlets inside a common nacelle, as illustrated in (Fig. 1), which raises questions about potential interactions between neighbouring fans, especially in off-design (e.g in side-slip conditions), and poses a challenging multi-point design exercise.



Fig. 1. NASA N3-X blended-wing-body configuration with distributed propulsion[1].

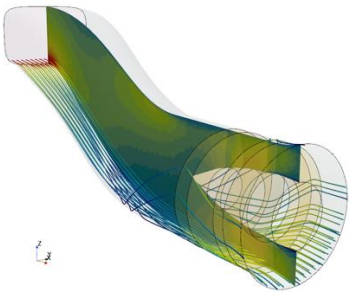


Fig. 2. Numerical simulation of a semi-embedded fan using body-force modelling (BFM).

MISSIONS:

In this project, we propose to design a mail-slot-type nacelle (Fig. 1) for a given blended-wing-configuration, composed of a spanwise array of fans, semi-embedded in the airframe via neighbouring s-ducts. In order to simulate the strong fan-inlet interactions and the fan

[1] M.-F. Liou et al., Aerodynamic Design of Integrated Propulsion-Airframe Configuration of the Hybrid Wingbody Aircraft, in *35th AIAA Applied Aerodynamics Conference*, 2017.

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performance under distortion, we propose to model the fan stages by using a body force approach in a Reynolds-averaged Navier-Stokes solver. This principle, not new in turbomachinery, has been used to deal with short nacelles[2], cross-wind conditions[3] or aero-propulsive coupling[4]. Although this method cannot give access to the whole phenomenology of the flow inside the thrusters, it is able to capture first order phenomena with lower computational cost, compatible with aerodynamic shape optimization.

The proposed work will pursue ongoing efforts to develop an adaptive nacelle design framework, using in-house Python scripts for geometry generation, body-force modelling, and the commercial StarCCM+ solver. We will investigate means to refine the geometry through aerodynamic analysis and shape optimization. Special attention will be given to identifying critical conditions in off-design (e.g incidence, side-slip) and the importance of aerodynamic. We will also explore scaling effects and define requirements for future wind tunnel or flight tests.

REQUIRED PROFILE:

We are looking for an enthusiastic researcher with a degree in Fluid Mechanics, Energetics or a closely related discipline, with a strong background in computational fluid dynamics, modelling and post-processing techniques (PhD or MSc with proven experience in computational fluid dynamics). Experience in CFD of turbomachinery or aerodynamic shape optimization will be highly appreciated.

As the project is part of a larger European project, collaborative skills are important too. Excellent English, communication and reporting skills are required. Comfort with working both independently and in a team, as well as a pro-active, problem-solving and result-oriented work attitude is highly regarded. The appointee is expected to publish (journal or conference paper), participate in the regular internal project meetings, and contribute to project deliverables.

EXPERIENCE: 0 - 3 years

[2] Thollet, W. Body Force Modeling of Fan—Airframe Interactions. Diss. Ph. D. thesis, ISAE-SUPAERO, 2017.
[3] Minaker, Quentin J., and Jeffrey J. Defoe. "Prediction of Crosswind Separation Velocity for Fan and Nacelle Systems Using Body Force Models: Part 1: Fan Body Force Model Generation without Detailed Stage Geometry." International Journal of Turbomachinery, Propulsion and Power 4.4 (2019): 43.
[4] Benichou, Emmanuel, et al. "Numerical Low-Fidelity Method for Improved Analysis of Breakthrough Aero-Propulsive Systems ." 1st Aerospace Europe Conference, 2020.

DURATION : 13 months, with a possible extension after the first 13 months
LOCATION : TOULOUSE

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APPLICATION PROCESS: Applicants should submit their letter of application along with a detailed curriculum vitae, a list of publications, title and abstract of PhD dissertation, contact information of at least one academic reference and all other information that might be relevant to Dr. Nicolás García Rosa (nicolas.garcia_rosa@isae-supaero.fr).

APPLICATION DEADLINE: 14/02/2027
REFERENCES: 2026-dp-inlet