**PhD in Aerospace Engineering**

**eXOADD Project : eXtended overall aircraft design through digitalization**

Context :

The Institut Supérieur de l'Aéronautique et de l'Espace (ISAE-SUPAERO) was born in October 2007 from the merger of ENSICA (1945) and SUPAERO (1909). ISAE designs and delivers multidisciplinary and high level training programs that always include a systems approach, and that cover the fields of aeronautics, space, energetics, information systems and embedded systems. In particular, research at ISAE-SUPAERO covers activities related to aircraft design and operations.

The AIRBUS-ISAE CEDAR for Eco-Design of Aircraft was signed in June 2013 for 5 years, funded by a 2.5M€ AIRBUS donation to the ISAE-SUPAERO Foundation. It is intended to conduct different actions in order to contribute to the sustainable development of future air transportation, taking into account the many dimensions of that ambition (environment, society, economic & industrial issues …).

Since early 2016, and in collaboration with the Preliminary Design division at Airbus Toulouse, several research projects have been running on two themes, Distributed Propulsion Regional and Blended Wing Body (BWB) configuration. Both technologies are candidates for delivering lower emissions.

Three PhD students (co-supervised with ONERA) are now engaged on themes closely related to the aforementioned key research orientations. The purpose of this call is to recruit the fourth PhD student and to challenge traditional aircraft design.

**Project outline:**

Aircraft digitalization, operations and support have become an essential component for all actors in the aviation business, taking an increasingly significant place through the production of a large volume and a wide variety of operational data. This new situation leads to taking into account, at preliminary design stage, criteria such as operations, maintenance, economic added value, development time or certification.

The data flow and decisions resulting from their analysis - by more or less complex algorithms - are essentially elements aimed at optimizing availability and Direct Operating Cost (DOC) of aircraft. It also allows optimal definition of systems through the use of resources and/or services dedicated to health monitoring, advanced maintenance, operational support.

These operational data flows also open up highly relevant perspectives for challenging current design and certification methods that rely on robust and proven solutions, often underpinned by conservative assumptions in certification regulations. The certification of an aircraft can today be perceived as a "fire-and-forget" process in which the conformity of a design is verified on the basis of assumptions relating to the operation of the aircraft (cf. "Introduction to EASA guidelines" in Guidance Material 21A.3B - EASA Part 21), which may not be verified or challenged after the issuance of the type certificate. In the same way that a Vehicle Health Management system will rely on data to improve reliability of an aircraft and its equipment (through a better understanding of their

condition, advanced predictions or predictive maintenance), it is relevant to study how the use of this large volume of information can optimize the preliminary design of the aircraft and the certification assumptions here above mentioned.

This research aims at developing a disruptive methodology, and associated multidisciplinary models, for preliminary design and certification of an aircraft taking into account operational data flows, and more broadly, contributions of digitalization. The objective of this methodology is to redefine the current assumptions or requirements through a dynamic management of the knowledge of the real state of an aircraft and its operational and physical environment. This knowledge management process would help reduce the operational uncertainties that now lead to existing conservatism, and by declination would allow for optimized designs and more relevant certification while ensuring compliance with the adequate safety objectives. Data-models built and updated on the basis of these data flows would be used to create, improve and/or parametrize preliminary design calculation bricks. Those will be compatible with the multi-disciplinary aircraft design tools used by ISAE-SUPAERO and Research Federation (FAST, OpenMDAO). A probabilistic approach of dimensioning and certification criteria could also be introduced in the computational bricks, making it possible to challenge hard criteria applicable today. Finally, a demonstration of the new proposed rules could be considered to verify, on the basis of test-cases of increasing complexity, the coherence of the disruptive methodology developed. It could be achieved by prototyping or virtual test integrating changes of sizing rules and using a loop of integrity control.

**Relevant references**:


- Curran, R., Price, M., Raghunathan, S., Benard, E., Crosby, S., Castagne, S., & Mawhinney, P. (2005). Integrating aircraft cost modeling into conceptual design. *Concurrent Engineering*, *13*(4), 321-330
- Schmollgruber, P., Bartoli, N., Bedouet, J., Defoort, S., Gourinat, Y., Benard, E., ... & Sgueglia, A. (2017). Use of a Certification Constraints Module for Aircraft Design Activities. In *17th AIAA Aviation Technology, Integration, and Operations Conference* (p. 3762)
- Nguyen Van, E., Troillard, P., Jézégou, J., Alazard, D., Pastor, P., Döll, C (2018). Using Differential Thrust with Distributed Electric Propulsion: Infuence of Conguration and Thoughts on Certification Requirements. AEGATS'18


**PhD supervision** : Prof. Y. Gourinat, Ass. Prof. J. Jézégou, Ass. Prof. E ; Bénard

**Funding** : ½ CEDAR chair (Airbus sponsored) – ½ ISAE Doctoral Studies

**Starting date**: ideally before end of 2018

**Contact**: Joel.JEZEGOU@isae.fr