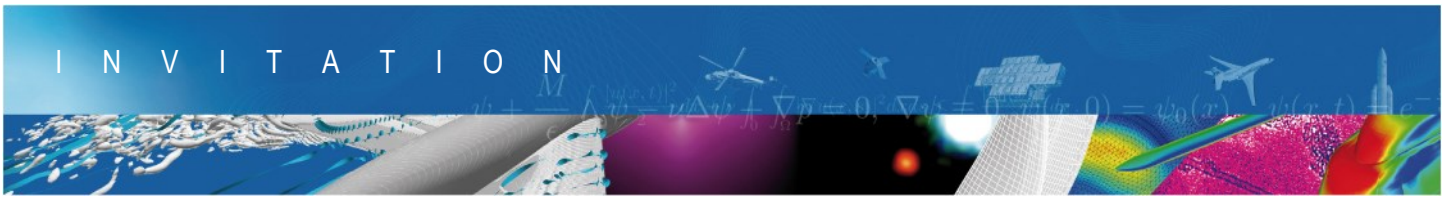

Sizing and optimisation priorities applied to a Blended Wing-Body with distributed electric ducted fans

Soutenance de Thèse – Alessandro SGUEGLIA

Mardi 10 décembre 2019 à 14h00

Salle des thèse ISAE-SUPAERO

Devant le jury composé de :

Christian Bes	Professor, Université Paul Sabatier	Examinateur
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Fabrizio Nicolosi	Adjoint professor, Università di Napoli “Federico II”	Examinateur
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Trevor Munro Young	Adjoint professor, University of Limerick	Rapporteur
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Résumé

The increase of air traffic in the last decades and its projections pose a key challenge towards the carbon neutral growth objective. To cope with this societal goal, there is a need for disruptive air transport aircraft concepts featuring new technologies with low environmental impact. Such future air vehicle relies on the various interactions between systems, disciplines and components. This Ph.D. research thus focuses on the development of a methodology dedicated to the exploration and performance evaluation of unconventional configurations using innovative propulsion concepts. The use case to be considered is the optimization at conceptual level of a Blended Wing-Body with distributed electric propulsion, a promising concept which combines high aerodynamic performances and benefits from electric propulsion.

The optimization process based on FAST, the ISAE-SUPAERO / ONERA aircraft sizing tool, has been implemented within OpenMDAO, the NASA open-source multidisciplinary analysis and optimization framework. With the idea of a progressive enhancement of the multidisciplinary design analysis and a better capture of the different effects, the two pioneering elements have been studied separately: methodology to take into account the innovative hybrid powerplant and airframe design have been studied first, and the design process for the considered use case is obtained combining them.

Regarding the design process, results show that the use of gradients in the optimization procedure speeds up the process against a gradient-free method up to 70%. This is an important gain in time that facilitates designer’s tasks. For the disruptive concept performances, results have been compared to the ones obtained for a conventional A320 type aircraft based on the same top level requirements and technological horizon.

Overall, the hybrid electric propulsion concept is interesting as it allows zero emissions for Landing/Take-Off operations, improving the environmental footprint of the aircraft: fuel can be saved for missions below a certain range. This limitation is associated to the presence of batteries: indeed they introduce indeed a relevant penalty in weight that cannot be countered by benefits of electrification for longer range. Additional simulations indicate that a Blended Wing-Body concept based on a turbo-electric only architecture is constantly performing better than the baseline within the limits of the assumptions.

Mots clés

aircraft design, multidisciplinary design optimisation, blended wing-body, distributed electric propulsion.