Design and optimization of aircraft engine nozzles in under-wing configuration

SOUTENANCE DE THESE – **Simon BAGY**

Vendredi 04 Septembre 2020 à 14h00 - Salle AY 02-63 à l'ONERA Meudon

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Résumé :

When aircraft have under-wing propulsion systems, aerodynamic interactions appear between engines and wings. The trend of increasing turbofans by-pass ratio in order to improve their efficiency leads to greater engine diameters, and therefore strengthens these installation effects. In particular, the engine rear- body and the nozzles are located in the vicinity of the wing pressure side and are directly concerned by these interactions. In order to take these effects into account during early design phases of nozzles aerolines, the present thesis work aims at developing design approaches based on aerodynamic shape optimization methods, with industrial tools (such as CAD) and coupled aeropropulsive simu- lations. Industrial geometrical models are usually defined with commercial CAD software and comprise hundreds of design parameters. However, a literature re- view on optimization methods shows the difficulty of considering these software as well as a high number of design variables. Consequently, an original approach called convex combination is proposed. This method enables a dimensional re- duction for the optimization problem, by using industrial know-how to define a subspace of the design space. Thus, it allows the use of most optimization meth- ods for optimum research on the subspace. At first, this approach is tested and validated on a 2D single-flow nozzle case. On this case without CAD, exploring a subspace appears capable of outperforming full-space research. Then, a case of industrial complexity is defined, with a CAD geometry of turbofan nacelle and dual separate flow nozzles. Optimizations performed on this isolated na- celle (without aircraft) validate the use of the proposed approach with industrial design tools. Finally, some developments towards fully-coupled aeropropulsive simulations are made. In the end, these simulations coupling aerodynamics to a thermodynamic engine model are expected to be integrated in the optimization workflow. The thesis work consisted in developing optimization strategies and workflows adapted to the design of aeronautic turbofan nozzles, while consid- ering industrial use cases and tools. Although the final application case on a complete aircraft with under-wing engines has not been covered in this work, the proposed convex combination approach and the associated workflow will allow to carry out this study in the near future.

Mots clés : UHBR engine, coupled aero-propulsive optimisation, CAO vs. Optimisation