INSTITUT CLÉMENT ADER

**Post doctoral position – 18 months**

# HPC topology optimization for innovative structural designs for the integration of a jet engine on civil aircraft

## Industrial background

The integration of latest jet engine for aircraft are a challenge for both aircraft manufacturer and engine manufacturer. Usual designs show their limitations and engineers face difficulties to fulfill integration criteria to ensure a reliable design. Also, overall aircraft performance must be improved thanks to a better engine integration on the aircraft. Therefore, engineers have to imagine disruptive architecture and design for the components (air inlet, nacelle, pylon) surrounding the engine in order to answer to these challenges.

## Research background

In this context, structural optimization is a key feature for improving existing products and finding disruptive concepts. In particular, topology optimization [1] appears quite promising in this context, as it deals with the determination of the optimal structural layout, given various performance objectives (e.g. stiffness) and constraints (e.g. maximum stresses). For this reason it can be used to inspire non-conventional solutions or derive design principles for similar problems.
In this work we are interested in the topology optimization of the attachment zone between the engine and the wing on a typical commercial aircraft. This attachment will have to transmit all the loads from the engine to the rest of the airplane and vice versa, while simultaneously being subject to numerous constraints. To further complicate matters the engine finite element model cannot usually be modified. Accordingly the topology optimization design zone will have to be connected through a non-conforming interface to the engine model. One of the existing solutions for tying non-conforming interfaces [2] will thus have to be used throughout the topology optimization. Furthermore, in order to reduce numerical costs it makes sense to statically condense the engine model (which doesn't change along the topology optimization) through a superelement formulation. Finally a performance objective function has to be derived and optimized based on the engine tip clearances (i.e. specific engine deformations). An initial framework for solving this topology optimization problem has been proposed in [3],[4]. One of the major limitations of this existing work resides in the computational cost of the approach. Indeed the design zone of the topology optimization has to be meshed very finely in order to obtain the most detailed designs. Currently topology optimization with 1.5 million degrees of freedom in the design zone were successfully implemented [4]. In this work we seek to achieve much finer design spaces through the use of high performance computing on the Olympe cluster of Calmip, the regional supercomputing center. On a much simpler problem, topology optimization with 1 billion degrees of freedom were recently achieved [5] and the corresponding code based on the PetSC framework was released. The main objective of this work is thus to develop and implement HPC techniques (such as in [5]-[7]) to extend the topology optimization of the engine-wing attachment of [3],[4] to up to 50 times more degrees of freedom.

**Candidate profile**

- PhD in Mechanical Engineering
- Strong experience with finite element numerical implementations expected
- Working knowledge of C++ expected
- Experience with HPC would be a plus

**Salary**

Depending on experience.

**Contact**

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**References**

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