Aurélien ARNTZ Doctorant à l'Onera soutiendra ses travaux de thèse :

« Civil Aircraft Aero-thermo-propulsive Performance Assessment by an Exergy Analysis of High-fidelity CFD-RANS Flow Solutions**»**

le Vendredi 28 novembre 2014 à 14h00 à l'Onera Meudon (Salle AY 02 63)

devant le jury composé de :

RAPPORTEURS

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ABSTRACT

Global market forecasts predict a doubling of the air traffic within the next 15 years which raises environmental concerns. The aerospace industry must consider breakthrough concepts such as boundary-layer ingestion propulsion systems to meet environment regulations while ensuring the growth of the air travel.
However, the tools and methodologies currently used for the design of commercial aircraft have been initiated decades ago and are based on simplifying assumptions that become excessively ambiguous for highly integrated propulsion devices for which traditional drag/thrust bookkeepings become inapplicable. Likewise, the growing complexity of civil aircraft requires a more global performance assessment which could take into account thermal management.
As a consequence, a new exergy-based formulation is derived for the assessment of the aerothermopropulsive performance of civil aircraft. The choice of exergy is motivated by its ability to provide a well established and consistent methodology for the design of aerospace vehicles. The output of the derivation process is an exergy balance between the exergy supplied by a propulsion system or by heat transfer, the mechanical equilibrium of the aircraft, and the exergy outflow and destruction within the control volume.
The theoretical formulation is subsequently numerically implemented in a Fortran code named ffx for the post-processing of CFD-RANS flow solutions. Unpowered airframe configurations are examined with grid refinement studies and a turbulence model sensitivity analysis. The code is thereby validated against welltried methods of drag prediction or wind-tunnel testings when available. A numerical correction is introduced and calibrated to obtain an accuracy similar to the near-field drag method.
Finally, the investigation of powered configurations demonstrates the ability of the approach for the performance assessment of configurations with aerothermopropulsive interactions. First, the formulation is validated to the simple case of a turbofan engine for which consistent figures of merit are exhibited. The formulation is also proved robust to assess the overall performance of a boundary layer ingesting propulsion system placed on the upper surface of a simplified blended wing-body architecture. This configuration also enables the investigation of thermopropulsive interactions by the transfer of heat upstream of the propulsion system. Subsequently, the integration of a heat exchanger on a commercial aircraft is examined for which the exergy point of view provides guidelines for an efficient system. The ability of the formulation to consistently assess all these types of subsystems is a clear benefit of the work.

Keywords: exergy, energy, performance, CFD, aerodynamics, propulsion