Multidisciplinary Overall Aircraft Design and Optimization of Blended Wing Body Configurations

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The Blended Wing Body (BWB) configuration seems to be one of the most promising concepts to replace the current passenger transport aircrafts with substantial improvement of their performances and reduction of the air transport environmental footprint.

The typical features of the BWB configuration is that each subsystem, as propulsion, control surfaces, pressurized cabin, *etc*. is integrated to a wing shaped body. Thus, the design of such geometry imposes to consider, at the same level of the overall aircraft design, several disciplines such as aerodynamics, structure, propulsion, handling qualities, *etc*. Therefore, the use of multidisciplinary approaches is crucial in order to take into account the complex couplings between disciplines involved in its design and optimization.

Onera has developed a Multidisciplinary Design Analysis and Optimization (MDAO) process dedicated to BWB configurations throughout the internal research project CICAV. The first phase of the CICAV project is dedicated to the definition of the specifications and requirements of the expected multidisciplinary design and optimization process. Then, the geometric parameterization for BWB configurations is fully defined with the goal of being able to describe several BWB internal arrangements and overall airframe geometries. This approach led to the exhaustive definition of the process with the identification of the required disciplinary modules (type of models, internal processes, local design loops, *etc*.) and their attached variables (inputs, outputs). Those elements allow identifying the process data flow and system couplings.

Based on these specifications and data flow definition, the multidisciplinary design and optimization process is implemented, with the integration of disciplinary modules specifically developed or adapted for the BWB purpose. The CICAV process is composed of the following disciplinary modules:

- Geometry: overall airframe definition and internal pressurized part sizing,
- Propulsion: engines performances definition,
- Structure: primary structure sizing and weight and balance computation,
- Aerodynamics: aerodynamic characteristics assessment,
- Mission: performances assessment with regard to the specified mission,
- Handling Qualities: handling qualities assessment and control solutions definition.

In the first part of the paper, the multidisciplinary design process will be detailed in addition with a description about the implemented disciplinary modules.

In the second part of the paper, using this MDAO process, a BWB configuration is designed with long-haul commercial transport mission specifications. They are based on the A350-1000 which entered in service in February 2018. In order to determine the most influential design variables among all the BWB parameters, a sensitivity analysis on the objective function and the constraints is carried out enabling to set the MDO problem to be solved. An MDO process is performed on the BWB concept with regard to performance objective under constraints (minimal performances, structural sizing rules, compliance with airport infrastructures, *etc*.). The performance objective is expressed as the minimization of the fuel weight for achieving its mission.

The final paper will describe the MDO process and the results of the BWB baseline design that fulfils the long-haul commercial transport mission.

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