Enhancement of the aircraft design process through certification constraints management and full mission simulations

Soutenance de thèse – Peter SCHMOLLGRUBER
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Résumé

In the field of civil transport aircraft, environmental constraints set challenging goals in terms of fuel consumption for the next generations of airplanes. With the “tube and wing” configuration offering low expectations on further improvements, disruptive vehicle concepts including new technologies are investigated. However, little information on such architectures is available in the early phases of the design process. Thus, research in Aircraft Design aims at adding knowledge in the Multidisciplinary Design Analysis. This objective is currently achieved with different approaches: implementation of Multidisciplinary Design Optimization, addition of accuracy through high fidelity analyses, introduction of new disciplines or systems and uncertainty management. In a preliminary study, the optimization of transport aircraft featuring ground based assistance based on a monolithic architecture and advanced structural models has been completed. The subsequent analysis of the outcomes highlighted specific needs towards the design of a viable concept. This research proposes then to add knowledge through an expansion of the Multidisciplinary Design Analysis and Optimization with a new Certification Constraint Module and full simulation capabilities.

Following the development of the Certification Constraint Module (CCM), its capabilities have been used to perform four optimization problems associated to a conventional civil transport aircraft based on the ONERA / ISAE-SUPAERO sizing tool called FAST. Facilitated by the Graphical User Interface of the CCM, the setup time of these optimizations has been reduced and the results clearly confirmed the necessity to consider certification constraints very early in the design process in order to select the most promising concepts. To achieve full simulation capabilities, the multidisciplinary analysis within FAST had to be enhanced. First, the aerodynamics analysis tool has been modified so that necessary coefficients for a 6 Degrees-of-Freedom model could be generated. Second, a new module computing inertia properties has been added. Last, the open source simulator JSBSim has been used including different control laws for stability augmentation and automated navigation. The comparisons between flight trajectories obtained with FAST and real aircraft data recorded with ADS-B antenna confirmed the validity of the approach.

Mots-clés

Aircraft design, Multidisciplinary Design Analysis and Optimization, Certification constraints, simulation, ADS-B

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