

Aeroelastic Shape Optimization of a Hybrid Regional Aircraft with Distributed Propulsion

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Contradicting requirements are one of the main characteristics of an aircraft design process and therefore multi-disciplinary optimization is the predestined tool to support here. Decarbonization is an emerging requirement for aviation which generates additional discrepancy with the minimum cost objective, the number one requirement in civil aviation. Solutions which reduce the environmental impact of aviation are being developed in the Clean Aviation framework program funded by the European Union including the project HERA [1] which investigates different aircraft concepts with and without distributed propulsion for the next generation of regional transport.

The sizing of the aircraft structure using optimisation is the current state of the art but the task to include the structural dependencies of other disciplines is ongoing. Here we are increasing the aerodynamic fidelity of our aeroelastic optimization process to be able to include the effects of distributed propulsion with propellers. At Airbus in Manching the foundation is the structural optimization software Lagrange [2] which has been developed in our perimeter for over 40 years. Recent developments were undertaken to provide model based structural sizing optimization during the concept phase via surrogate models [3]. This approach is suited to front-load the calculation effort of design studies with large numerical models and to include models which don't return design sensitivities. The optimization of the shape is done in a second step using a surrogate model based on the data generated before.

Adding multi-fidelity aerodynamics and extending these to a full aircraft model increases the accuracy of the optimisation process and likelihood of finding a robust optimal wing shape within the contradicting demands of minimum cost, environmental impact and aeroelasticity. This approach focuses on the addition of the influence of the distributed propulsion on the structural behaviour in the shape optimization of the wing and the effect of the propellers on the lift distribution which directly effects the induced drag. The main outcome presented here will be the optimized wing shape for a maximum range which also minimizes the fuel consumption for a fixed range.

This optimisation framework allows efficient search for the optimal aspect ratio accurately reflecting the effect on primary structural mass while at the same time including effects on aerodynamic efficiency including the distributed propulsion sufficiently accurately to drive the solution to an optimal compromise. The best solution cannot be found by only optimizing the different disciplines independently and sequentially. The quantity of the performance improvement of this optimization study needs to be reviewed critically if it is worth the weight and effort of the additional engines, electric systems and components.

Key Words: *Clean Aviation, HERA, MDO, Lagrange*

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