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Aeroelastic Adjoint-Based Optimisation of Highly Flexible Aircraft Wing Configuration

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Today in industry, during aircraft or engine design phases, most optimisation studies (both gradient-free and gradient-based) performed using High-Fidelity (*HiFi*) tools are focused on a single discipline (aerodynamics, structural analysis acoustics ...). In order to demonstrate the benefits of engaging Multi-Disciplinary Optimisation early in the industrial design campaign, the European H2020 MADELEINE project was launched in 2018 [1]. MADELEINE aimed at strengthening the capabilities and use of multi-physics adjoint solvers **Erreur ! Source du renvoi introuvable.** to maximise the benefit obtained from the computationally intensive simulations that are key enablers for future airframe and engine design.

In this context, one of the ONERA activities was focused on the aeroelastic adjoint capability applied to flexible wing design. In collaboration with Airbus Commercial Aircraft and DLR [3], ONERA performed a series of adjoint-based optimisations in order to measure the impact of considering aeroelastic effects (for aerodynamic performance through coupled CFD-CSM simulation on the one hand, and for the adjoint coupled sensitivities computation on the other hand) for increasing wing flexibility and design space size.

For this purpose, industrial tools were integrated in the complete optimisation chain. For the parameterisation, the Airbus CAD modeller PADGE was employed to modify the twist and camber of several control sections. A parametric Finite Element Model based on the CPACS-MoNa process was used to account for the wing flexibility and finally the *elsA* solver (ONERA-Airbus-Safran property) for the direct and adjoint coupled CFD-CSM simulations.

The final paper will detail all the results obtained by ONERA. The impact of engaging coupled aeroelastic direct and adjoint simulations as well as the impact of the number of design variables and turbulence model linearisation will be discussed.

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