AEROACOUSTIC OPTIMIZATION OF PROPELLER BLADES IN A PUSHER CONFIGURATION

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ABSTRACT

A multi-disciplinary analysis and optimization is carried out for a propeller in a real pusher aircraft configuration (as depicted in figure 1) with the goal of reducing the radiated noise power levels, while preserving the aerodynamic efficiency. The optimization process involves the shape of the blade and the position of the engine exhaust ducts. A coupling of the unsteady aerodynamic and structural-dynamic blade models provides the aeroelastic propeller model that drives a tonal and broadband aeroacoustic prediction. The whole Multi-Disciplinary Analysis (MDA) chain complies with the affordability required by an automatic optimization process.

The exhaust has a limited aerodynamic influence on the outer part of the blade. In practice, the sudden and strong variation of the blade loads in the exhaust region is not observed in the outer part of the blade (r/R > 0.75). This suggests to decouple the optimization of the inboard part of the blade from the outer part with the major advantage of reducing the design space.

Investigations of the blade inner and outer part are carried out using Design Of Experiment (DOE) with a twofold aim, the outline of the most promising regions of the design space, and the preparation of a database for the construction of the Response Surface Method (RSM). The subsequent multi-objective optimizations are based on evolutionary algorithms and they exploit both RSM and the full MDA process. An example of results is shown in figure 2.

The shape optimization reveals that the overall acoustic energy of the pusher propeller can be reduced up to a value of 3.5 dB. This reduction is nearly equally due to an optimal design of the blade planform in the tip and inner regions (figure 3). Extensive details are included in [1].

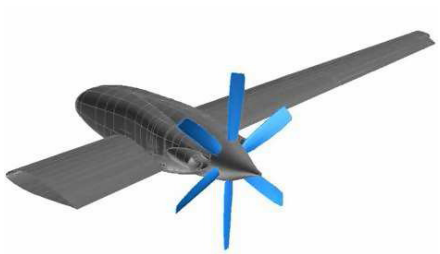

Fig. 1: the geometric configuration under analysis – in blue, the propeller to be optimized.

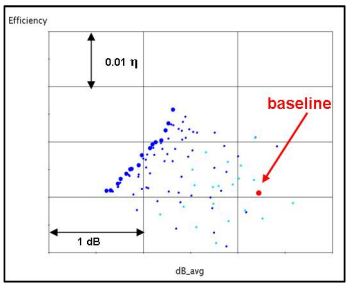

Fig. 2: example of optimization results – on the axis, the objectives of the optimization.

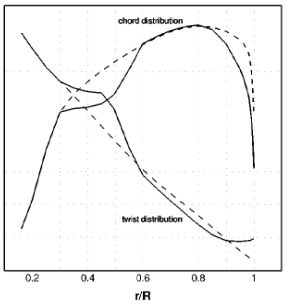

Fig.3: comparison between the baseline (dashed line) and the optimized (solid line) blades.

References

[1] A. Pagano, M. Barbarino, D. Casalino, and L. Federico, Tonal and Broadband Noise Calculations for Aeroacoustic Optimization of Propeller Blades in a Pusher Configuration. *Journal of Aircraft, Volume 47, Number 3, May-June* (2010).