Novel approach to multi-objective aircraft family optimization

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Aircraft sizing is the problem to determine optimal gross characteristics of future aircraft subjected to set of various requirements. Therefore, it is a global constrained optimization problem where constraints express physical/technical design feasibility while objectives are the market driven performances. Proper formulation of aircraft sizing problem typically results in multi-criteria optimization task because of competing objectives.

Recent advances in optimization methods and algorithms allow us to address the problem anew. In this paper we present some recent results obtained on improving aircraft sizing tool used in Airbus Future Projects Office. We also demonstrate the efficiency of MACROS Generic Tool for Optimization, developed by DATADVANCE, to solve complex aircraft sizing problem. In particular, we consider the task to optimize a family of three aircraft configurations driven by 12 degrees of freedom, such as wing area, wing aspect ratio, bypass ratio, engine thrust, etc., subject to 33 constraints, such as take-off field length, approach speed, climb ceiling, buffet ceiling, time to climb, fuel margin, etc., six of which being strict equalities. As far as relevant performance measures are concerned, we study 9 different aircraft characteristics simultaneously (maximum take-off weight, nominal fuel, operating costs for each of the three configurations) in order to make the test problem factually identical to real-life applications.

Thanks to MACROS Generic Tool for Optimization, which supports wide range of optimization problem types including constrained, multi-objective and robust formulations, we succeeded for the first time in extracting nontrivial Pareto frontier. We performed its analysis, identified the most impacting parameters and the set of active constraints. We have extensively used structured parallel coordinates and projections of Pareto set and frontier. This study has been performed within a timeframe compatible with Conceptual Design study cycle, which was not the case when using state of the art methods based on genetic algorithms.