Parametric Aircraft Design Optimisation Study Using Span and Mean Chord as Main Design Drivers

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Abstract. The present work describes an aircraft design methodology that uses the wingspan and its mean aerodynamic chord as main design parameters. In the implemented tool, low fidelity models have been developed for the aerodynamics, stability, propulsion, weight, balance and flight performance. A Fortran® routine that calculates the aircraft performance for the user defined mission and vehicle's performance requirements has been developed. In order to demonstrate this methodology, the results for a case study using the design specifications of the Air Cargo Challenge 2013 are shown.

Methodology

General Approach. The design methodology developed is based on an extensive parametric study developed in-house in a Fortran® routine whose primary design parameters are the wing span (b) and the wing mean chord (c). A similar optimisation methodology to the one adopted in this routine has been initially developed in a Microsoft Excel® workbook [1].

The program has two different primary *objective functions*: one is to *minimise the energy* mass for a surveillance mission and the other is to *maximise the payload* at take-off. In both cases, besides the standard mission itself, there are performance requirements that each wing layout must meet. Moreover, one of the most relevant design variables is unknown – the aircraft's Design Take-off Weight (DTOW). This will depend on the mission profile, performance requirements and on the wing span to mean aerodynamic chord combination, (Fig. 1).

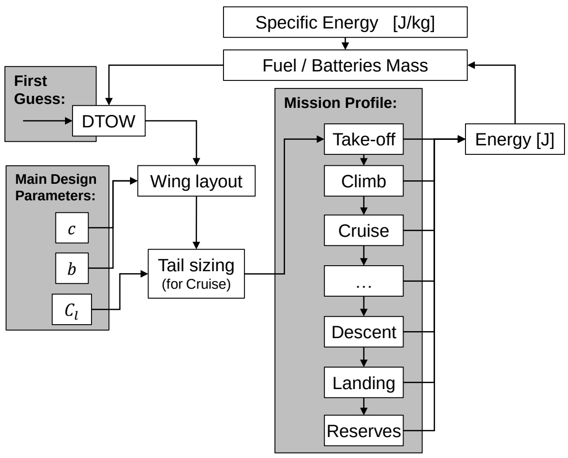

Figure 1 - Scheme featuring the iterative procedure for determining the DTOW, cruise velocity and tail sizing.

Physical Models. The physical models put into place are similar to the ones developed for the Microsoft Excel® workbook, with several exceptions. An enhanced physical model for the propulsion – that takes into account the propeller performance variation with rotational speed – and a more comprehensive stability analysis [2] which includes dynamic stability. The design process is based on the mission profile and performance requirements. Several iterative procedures have been implemented for each mission stage – so far only considering a standard flight including a take-off,