



DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

Conceptual Design of a Medium Range Box Wing Aircraft

Task for a Master Thesis according to university regulations

Background

Already in 1924 Ludwig Prandtl indicated that a wing system generating minimum induced drag consists of two wings whose tips are connected by vertical plates (**Prandtl 1924**). Today this configuration is mostly referred to as “box wing configuration”. Since a reduction of induced drag has positive effects on aircraft performance and weight, the box wing configuration has been subject of several studies (e.g. **Lockheed 1974**). However, only few of them contain a complete analysis of the overall design because of its unconventional nature and the lack of compatible methods. But with the growing availability of computational resources a complete design study becomes more feasible.

Because of its complexity, aircraft design often relies on statistical methods. These methods are applicable to new configurations only to a limited extent because most of them are based on conventional aircraft configurations. For this reason a reliable computational analysis of unknown configurations is mandatory, as well as experimental tests.

At the University of Applied Sciences Hamburg (HAW Hamburg) several tools are available for aircraft design. The tool PreSTo (Preliminary Sizing Tool) was developed within the Aero Research Group at HAW Hamburg, based on sizing calculations presented in the lecture “Aircraft Design” by Prof. D. Scholz (**Scholz 1999**). With its help a conventional aircraft can be sized in order to fulfill certain mission requirements. The generated data may be exported to other available tools for refining the design. One of these tools is the software suite CEASIOM (Computerized Environment for Aircraft Synthesis and Integrated Optimization Methods, URL: <http://www.ceasiom.com>). It was developed within the SimSAC project (Simulating Aircraft Stability and Control Characteristics for Use in Conceptual Design, URL: <http://www.simsacdesign.eu>) and enables the designer to analyze and optimize the design with the help of multidisciplinary methods.

Task

In this Master Thesis the conceptual design of a box wing aircraft shall be conducted with the help of the above mentioned methods and tools. Reference aircraft is the Airbus A320. In detail, the following tasks shall be performed:

- 1) Literature research
- 2) Discussion of essential parameters of the box wing configuration with regard to their special qualities compared to conventional aircraft
- 3) Preliminary sizing and conceptual design of the box wing aircraft equivalent with help of PreSTo
- 4) Multidisciplinary analysis of the box wing aircraft with help of CEASIOM
- 5) Comparison of the found box wing design with the reference aircraft in terms of weight and performance
- 6) Discussion of the results and the applicability of the used methods and software

For points 3) and 4) it has to be determined in which scope the software tools might be useful. Whenever needed, alternative methods have to be used and described.

The report has to be written in English based on German or international standards on report writing.

References

- Lockheed 1974** LANGE, R.H. ; CAHILL, J.F. ; BRADLEY, E.S. ; et al.: *Feasibility Study of the Transonic Biplane Concept for Transport Aircraft Application*. Marietta : The Lockheed-Georgia Company, 1974. - Research report prepared under contract NAS1-12413 on behalf of the National Aeronautics and Space Administration
- Prandtl 1924** PRANDTL, Ludwig: *Induced Drag of Multiplanes*. Langley : National Advisory Committee for Aeronautics, 1924. - NACA TN 182
- Scholz 1999** SCHOLZ, Dieter: *Skript zur Vorlesung Flugzeugentwurf*, Hamburg, Fachhochschule Hamburg, FB Fahrzeugtechnik, Abt. Flugzeugbau, Vorlesungsskript, 1999