Hochschule für Angewandte Wissenschaften Hamburg
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DEPARTMENT OF AUTOMOTIVE AND AERONAUTICAL ENGINEERING

Integration of a Noise Analysis Module into a Multidisciplinary Aircraft Design Process

Diplomarbeit at Hamburg University of Applied Sciences

Background

Community noise caused by aircraft during the initial and terminal phases of flight is a matter of increasing importance for the civil aviation industry. With airports increasingly operating near or at their capacity limit, one of the most promising means to enable further air traffic growth is to develop aircraft with minimum community noise impact, allowing them to avoid night time flying restrictions.

From an aircraft designer's standpoint, reducing aircraft noise to the levels needed to achieve this goal is a very challenging task. It is to be expected that such drastic noise reductions will not be achieved by merely working on mitigating noise sources on the aircraft in isolated form. Instead, the interactions of noise sources as well as shielding effects have to be considered and used to one's advantage. Aircraft noise becomes a configuration issue and thus has to be considered in the preliminary design stage [1].

At the DLR Institute of Aerodynamics and Flow Technology (AS), the Parametric Aircraft Noise Analysis Module (PANAM) has been developed, which allows the prediction of noise impact on the ground along arbitrary flight trajectories [2]. The module takes into account major airframe and engine noise components, as well as diverse effects on sound propagation.

At the Institute of Aircraft Design and Lightweight Structures (IFL), Technische Universität Braunschweig, the multidisciplinary integrated preliminary aircraft design process PrADO has been in development for some time [3]. The process features a modular structure which allows the easy addition of disciplines and analysis methods to the design process.

At HAW Hamburg the Green Freighter (GF) research project investigates environmentally friendly freighters. Aircraft configurations investigated in the GF project can be used for investigations in this thesis.

Objective

The objective of this thesis is the interconnection between PANAM and PrADO. This includes two modes of operation: On the one hand, PANAM shall be able to retrieve necessary configuration data for noise analysis from the PrADO databases (geometry, engine data, flight trajectories for take-off and final approach, etc.). On the other hand, PrADO shall be able to retrieve noise analysis results in a format allowing easy visualization, but also in a format suitable for use as an optimization target function. The completed process is to be applied to several aircraft designs, allowing a thorough discussion of process capabilities and of depicted parameter sensitivities. A written report shall document the theoretical background, the work performed and the results obtained, including an assessment of these results.

The following tasks have to be performed:

- Familiarization with the design tool PrADO as well as the noise analysis tool PANAM. Literature research concerning the topic of noise analysis.
- Definition of interfaces which allow PANAM to use configuration data derived out of PrADO, such as aircraft geometric data and engine characteristics
- Definition of interfaces which allow PANAM to use PrADO's flight simulation modules for the calculation of symmetrical flight trajectories during take-off and landing
- Formulation of a target function suitable for the consideration of aircraft noise as an optimization parameter in the preliminary aircraft design process
- Definition of interfaces which allow PrADO to use PANAM noise analysis results for evaluation of the formulated target function
- Implementation of the defined interfaces in the form of FORTRAN programs
- Application of the developed processes on different aircraft designs. Verification if expected parameter sensitivities are depicted. If possible, comparison of calculated noise data with literature data for the examined aircraft
- Documentation of the conducted work and discussion of the obtained results

Literatur

[1] SMITH, M. J. T.: *Aircraft Noise*. Cambridge University Press, Cambridge, New York, Port Chester, Melbourne, Sydney, 1989

[2] BERTSCH L.; DOBRZYNSKI, W.; GUÉRIN, S.: Tool Development for Low-Noise Aircraft Design, AIAA/CEAS Paper 2008-2995, 14th AIAA/CEAS Aeroacoustics Conference, 5-7 May 2008, Vancouver, Canada

[3] HEINZE, W.: Ein Beitrag zur quantitativen Analyse der technischen und wirtschaftlichen Auslegungsgrenzen verschiedener Flugzeugkonzepte für den Transport großer Nutzlasten, ZLR-Forschungsbericht 94-01, Braunschweig, 1994

The results have to be documented in a report. The report has to be written in a form up to internationally excepted scientific standards. The application of the German DIN standards is one excepted method to achieve the required scientific format.
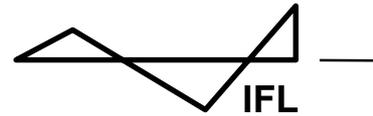
This thesis is conducted in cooperation with the Institute of Aerodynamics and Flow Technology (AS) of the German Aerospace Center (DLR) and with the Institute of Aircraft Design and Lightweight Structures (IFL), Technische Universität Braunschweig