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Analytical fuselage structure mass estimation using the PANDORA framework

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Abstract

Air traffic emissions have a significant impact on our environment and on the climate change. Since 2020, multiple research activities have been conducted at the German Aerospace Center (DLR) in the project “Exploration of Electric Aircraft Concepts and Technologies” (EXACT) to analyse the potential of eco-efficient aircraft concepts to reduce emissions. To handle the complexity on aircraft pre-design level, the usage of multidisciplinary design optimization (MDO) workflows and a common aircraft description format are an established procedure at DLR. The framework “Remote Component Environment” (RCE, [1]) is used to build MDO-workflows while the aircraft is described using the “Common Parametric Aircraft Configuration Schema” (CPACS, [2]).

Different specific disciplines for aircraft design are part of the EXACT project to assess hybrid-electric aircraft concepts including the estimation of flight performance, loads and structural masses of the aircraft. At the Institute for Structures and Design (BT) the primary fuselage structural mass is estimated for different aircraft concepts using fast analytical methods based on the fuselage geometry, the definition of primary structures like frames and stringers and the application of cut-loads on the fuselage for different loadcases. This capability is implemented in the Python-based modelling and sizing framework called “Parametric Numerical Design and Optimization Routines for Aircraft” (PANDORA, [3]), which is under development since 2016.

The PANDORA environment integrates developments like generating finite element (FE) models of aircraft based on CPACS parameters, converting FE models between different solver formats, creating and editing CPACS models and numerical as well as analytical sizing of aircraft models. In addition, more detailed FE models with different discretization approaches can be generated for crash and ditching simulations (EASN 2021 [4]).

An overview of the PANDORA framework and some results of the EXACT project are given in this presentation.

[1] Brigitte Boden, Jan Flink, Niklas Först, Robert Mischke, Kathrin Schaffert, Alexander Weinert, Annika Wohlan, and Andreas Schreiber. "RCE: an integration environment for engineering and science." SoftwareX 15 (2021): 100759. https://doi.org/10.1016/j.softx.2021.100759

[2] M. Alder, E. Moerland, J. Jepsen and B. Nagel. Recent Advances in Establishing a Common Language for Aircraft Design with CPACS. Aerospace Europe Conference 2020, Bordeaux, France, 2020.

[3] M. Petsch, D. Kohlgrüber and J. Heubischl, “PANDORA - A python based framework for modelling and structural sizing of transport aircraft”, EASN-CEAS, Glasgow, Scotland, 2018.

[4] C. Munoz, M. Petsch, D. Kohlgrüber, M. Pedelaborde-Augas, „Automatic tool-based pre-processing of generic structural models for water impact simulations in the aircraft pre-design”, EASN-CEAS, Virtual, 2021.