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Integration of the structural solver B2000++ in a multi-disciplinary process chain for aircraft design

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Abstract

Within the DLR project VicToria (2016 – 2020) multidisciplinary aircraft design process chains were developed to evaluate and optimize transport aircraft under a variety of different aspects such as aerodynamics, structural behaviour, flight control, etc. Aside from the different disciplines the process chains also combine analysis tools on different fidelity levels with the focus on sophisticated CFD and CSM methods based on Finite Element analyses [1]. For the transfer of aircraft parameters between the disciplinary tools a data format called CPACS (Common Parameterized Aircraft Configuration Schema) has been established [2, 3].

In a gradient free optimization process the modelling and sizing of the fuselage structure is performed using the PANDORA (Parametric Numerical Design and Optimization Routines for Aircraft) software framework. The PANDORA development started in 2016 to replace a set of established individual tools for model generation and structural sizing [4, 5] with the objectives to increase flexibility and performance. One major decision was to use the interpreted high level programming language Python and further open source packages such a numpy, pandas, etc. to allow the application on a variety of computer systems from Windows PCs up to computer clusters. In addition, a VTK based graphical user interface has been added to make the model preparation and results evaluation independent from third party commercial software [6,7].

Recently the structural analysis and sizing process has been adapted to integrate the FE Solver B2000++ [8]. This solver was initially developed at SMR in Switzerland and is now available at the DLR including the source code for future developments and direct integration into High-Fidelity process chains.

In a first part of the paper recent developments of the PANDORA framework are presented after a brief overview of the MDO process chain and the CPACS data structure. These new developments include improvements in the model generation and the subsequent integration of structural analysis and sizing into the multi-disciplinary process chain. In this process the structural analyses can be performed using the established proprietary structural solvers ANSYS or NASTRAN. The validity of the results is proved by comparison with the previously used tools and the increase of performance is presented.

The second part of the paper focusses on the integration of the FE solver B2000++ into the process chain, which shall allow a further reduction of the global process runtime by starting several calculations in parallel without any software license restrictions. A set of benchmark simulations with B2000++ are performed and the results on basic element, coupon and component level compared with those obtained with proprietary solvers. Finally, the integration into the MDO framework and first simulations on full aircraft level are presented. The comparison within the MDO process will include accuracy and performance aspects.

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