# AIRCRAFT STRUCTURAL OPTIMIZATION SUBJECT TO FLIGHT LOADS – APPLICATION TO A WIDE BODY COMMERCIAL AIRCRAFT CONFIGURATION

FELIX STROSCHER

*Institute of lightweight structures (LLB), Technical University Munich*
*85747 Garching b. München, Germany*[*]
*stroscher@llb.mw.tum.de*
*http://www.llb.mw.tum.de*

ÖGMUNDUR PETERSSON

*Institute of lightweight structures (LLB), Technical University Munich*
*85747 Garching b. München, Germany*[†]
*petersson@llb.mw.tum.de*
*http://www.llb.mw.tum.de*

MARTIN LEITNER

*Institute of lightweight structures (LLB), Technical University Munich*
*85747 Garching b. München, Germany*[‡]
*m.leitner@llb.mw.tum.de*
*http://www.llb.mw.tum.de*

**Abstract**

The herein presented approach couples the traditional nonlinear flight dynamics model and the aeroelastic model to take into account the prediction capabilities of both in aircraft flight loads analysis. A wide-body commercial aircraft configuration, developed in the European FP7 research project ACFA2020, is used as application example. Two transient simulations are performed, a steady pull-up and discrete gust response. The resulting sizing loads are found and applied as equivalent static loads on the aircraft finite element model. Subsequent structural optimization of the airframe, under simplified conditions, underlines that a coupled process of loads analysis and structural optimization is possible.

**Keywords** Structural optimization, aircraft, aeroelasticity, gust loads, maneuver loads

## 1. Introduction

Traditionally flight loads for structural sizing are derived from flight mechanics models including structural displacements only as flex factors. Structural dynamic effects in transient maneuver simulation are not accounted for, when doing so. Transient gust loads are also relevant for sizing but are normally computed by linear aeroelastic models, which cannot represent the nonlinear flight dynamic response of the aircraft, when hit by a gust. Both deficits can be eliminated when coupling the nonlinear flight dynamics model to the aeroelastic model.

Such structural sizing loads have to be computed at least once before the sizing process with an initial design. If changes to the mass and stiffness distribution are considerable the loads need to be recalculated and the sizing process repeated. The integration of the whole loads analysis in the structural optimization loop would enable an intelligent loads-oriented sizing, while speeding up the process. Moreover the manual iteration loops between loads analysis and structural design would be avoided, saving costs and time in aircraft design.