

Simulation of Aeroelastic Equilibrium of the FA18 aircraft

Altitude: 5000 ft
Velocity: Mach 0.7
Angle of Attack: 15.9 degrees
Load: 8.25g

CAD repair and CFD mesh generation
CFD simulation with NSMB
Volume-mesh deformation

CFS Engineering SA

Customer
Supplier of CFD CAD geometry and FEM model
CSM simulation with Nastran

RUAG
Aerospace Defence Technology

Geometrical Coupling
Post-processing of results

SMR
Engineering & Development

Aerodynamic pressures and skin friction forces are integrated to nodal surface grid. The resulting force field is then transferred to the structural grid. In conjunction with the force- and strain-energy conservative geometrical coupling tools, this approach ensures a high fidelity of the transferred quantities.

Our in-house geometrical coupling tools FSCON and FSI are capable of multi-region coupling, an essential feature for high-lift configurations such as the FA18. The graphical pre-processor FSCON allows for interactive definition of the individual coupling groups, while FSI implements the industrial-strength volume-spline method to transfer forces and displacements.

All tools, from the CFD mesh-generator to the FEM-Solver B2000, are tightly integrated and feature excellent interoperability. This, together with the long-standing expertise in fluid dynamics and structural mechanics, gives CFS and SMR the means to provide rapid solutions to demanding problems in aeroelastics.

SMR's B2000 Finite Element Solver features state-of-the-art technology for problems involving linear and non-linear elasticity. Alternatively, an interface to Nastran provides a gateway to industry's standard FEM tool. Our post-processor baspl++ handles both fluid and structural models, thus providing a means for comprehensive synthesis of the results.

Flow fields around the FA18 are computed using the NSMB flow solver (Navier Stokes Multi Block, a structured and well-parallelized flow solver using the finite volume method). The computed aerodynamic forces are in good agreement with experimental and flight data. A typical calculation using 8 million grid cells requires 30 hours on 6 PCs. Additional iterations for the static deformation take in the order of 4 hours on the same computers.

Our volume mesh deformation tool allows us to move the 8 million cells of the FA18 mesh according to the structural deformation. Because the FA18 was modeled in detail (for example the wing with deflected trailing edge flap, and gap between the trailing edge flap and aileron), the success of the deformation of the mesh is a real achievement and shows the strength of our tool. The computation takes only 1.5 hours on a single PC.

