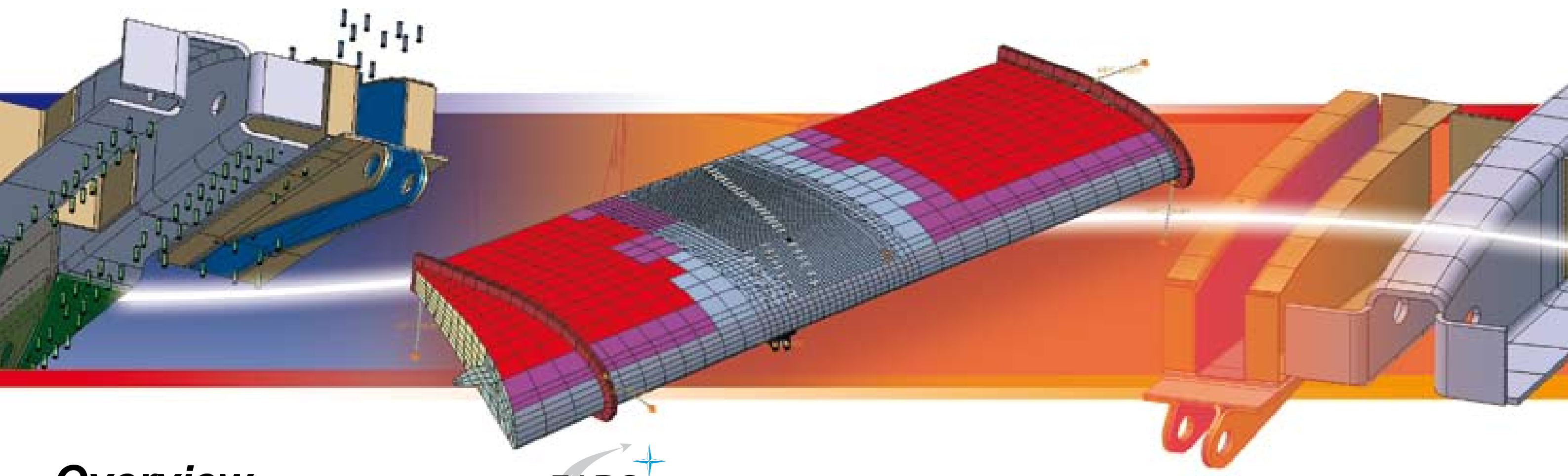
EADS

Greener, cleaner aircraft with Abaqus FEA from SIMULIA



Overview

Challenge

EADS needed to produce "greener and cleaner" aircraft by incorporating complex composite structures in its designs.

Solution

EADS chose SIMULIA's Abaqus FEA and its powerful composite analysis capabilities to obtain an accurate analysis of the LIR, the wing flap support structure of aircraft.

Benefits

Producing an accurate analysis of the design with Abaqus FEA enabled EADS to simplify the LIR's geometry resulting in reduced manufacturing costs.

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Dr. Tamas Havar
Specialist
EADS Innovation Works

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Sustainable aircraft design takes off

Based on a 2001 report by the Advisory Council for Aeronautics Research in Europe (ACARE), which set goals to decrease environmental impact of the aeronautics industry, Europe's leading aerospace corporation, EADS (European Aeronautic Defence and Space), and its business units and aerospace partners are actively engaged in the development of "greener, cleaner" commercial aircraft. The goals defined by ACARE - to cut aircraft fuel consumption 50%, CO_2 emissions 50%, and NOx emissions 80% - can be met if aircrafts become lighter, more fuel efficient and are able to fly for longer distances. One strategy to achieve these goals is to replace metal components with innovative composite structures.

Dr. Tamas Havar, specialist at EADS Innovation Worksite near Munich, Germany, and his team are tasked with developing new aircraft structures using composite materials. The project, led by Airbus High-Lift Center in Bremen, the second largest Airbus site in Germany, is a joint effort between different EADS Business Units. "The goal of our ongoing analysis program," Havar said, "is to reduce emissions and manufacturing costs by focusing on the development of innovative composite design and manufacturing methods."

A critical factor in the design of composite aeronautic structures is how the parts attach to the surrounding aircraft structure. Current composite high-lift structures—such as a flap—typically utilize metal load introduction structures to attach to the wing. These structures, with fail-safe designs, lead to heavier aircraft and higher manufacturing costs. There are also differences in thermal coefficients between the metal and composite parts that are connected. Composite load introduction structures, on the other hand, permit a damage tolerance design, since a failure of one ply is compensated by other plies that remain intact. The use of composite material also eliminates the problem of thermally induced loads, since both the

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high-lift and load introduction structures are made of the same composite materials.

Abaqus FEA fuels composite structure analysis

For design analysis of its composite LIR, an important wing flap support structure, the EADS Innovation Works team chose Abaqus FEA. "Abaqus is our preferred nonlinear solver," said Havar. "It has powerful composite analysis capabilities, especially for 3D elements such as in our LIR study." Abaqus FEA is used throughout the product design life cycle at EADS—in the concept phase, to narrow down the designs; in the pre-design phase, to design the preferred concept; and in the final or detailed design stage, to ensure that all specifications are met.

The team's goal was to decrease manufacturing costs by simplifying the LIR's geometrically complex pre-form so that its thickness was uniform, except in those areas where pre-forming could be relatively simple and inexpensive. The team's solution used LIR profiles that allowed the pre-form lay-up to be automated, thereby minimizing manufacturing costs.

To model the new design, the EADS team needed to consider the complexity of the composite structures such as variable thicknesses and plies chamfered with resin pockets. "Given the variables inherent in composites, we needed to use 3D elements to calculate composite load introduction and to obtain an accurate analysis of all stress components," said Havar. "Since delamination is a common type of failure for composite load introduction, both the transversal shear and peel stresses are of high interest." With these factors in mind, the EADS engineering group constructed the LIR model using a variety of different Abaqus elements for a total of approximately 450,000 degrees of freedom (DOF).

The engineering team also had to demonstrate that every single one of the 324 rivets in the assembly, which attach the LIR to the surrounding structure, was able to withstand the loading. "This is dependent not only on the attached structures but also on the rivet material and the size of the rivet itself," said Havar. To complete the LIR analysis, the EADS team calculated several load cases using the Abaqus implicit solver and postprocessing.

Positive results for composites analysis

If composites are key to the design of future sustainable "greener, cleaner" aircraft—with lighter weight, greater fuel efficiency, and fewer emissions—the results of the EADS composite analyses were positive on all counts: for the LIR, the in-plane and transversal stress components were within tolerances for the new composite design; for all rivets, the strength specifications for connecting the LIR to the surrounding structure were met or surpassed.

As EADS looks to incorporate more composite structures into its aircraft designs, the Innovation Works Lightweight Design team will be busy with a long list of FEA projects. "There's no doubt that composite structures will increase in future aircraft," said Havar. "To keep up with our ongoing innovation, we'll need additional FEA capabilities." As design engineers and FEA software developers work together on solving the analysis challenges, it looks like composites will certainly be a part of new, more environmentally friendly aircraft.

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