Composites Affordability Initiative
Composite Joint Analysis

PROBLEM / OBJECTIVE

The Composites Affordability Initiative (CAI) was established to reduce the cost of composite structures essential to high-performance aircraft. A team was established that consisted of the Air Force Research Laboratory Materials and Manufacturing Directorate, the Air Vehicles Directorate, the Office of Naval Research, Boeing, Lockheed Martin, Northrop Grumman and General Electric Aircraft Engines.

Early in the program the team recognized that in order for lower cost concepts to be accepted by the engineering community, accurate analysis of predicted performance was required.

ACCOMPLISHMENTS / PAYOFF

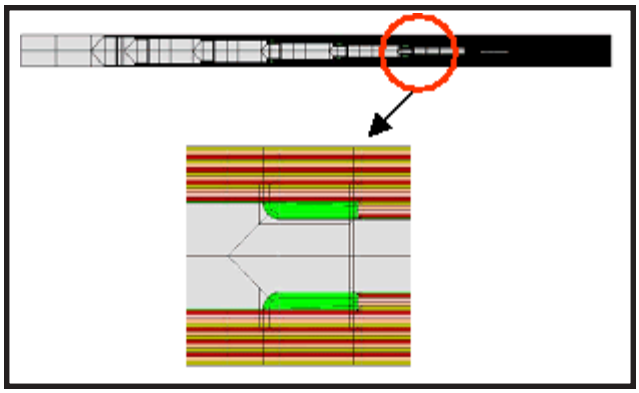
Process Improvement:

The use of CAI-developed enhancements to commercially available *Stress Check*™ P-version finite element software, coupled with the Strain Invariant Failure Theory (SIFT) originally developed by Boeing, and a CAI developed design handbook have resulted in a significant improvement in bonded and cocured joint strength prediction capabilities. This advanced methodology was demonstrated on the F/A-18E/F bonded wing root step lap joint.

Implementation and Technology Transfer:

The Foreign Military Sales (FMS) program identified a market for an F/A-18E/F with a 9g flight load capacity, an increase over the original 7.5g load capacity. Conventional strength analysis methods and test data indicated that the wing root step lap joint would have a negative margin of safety with a 9g load, even though element testing indicated adequate strength. As a result, the joint would need to be redesigned so that the structure could be certified for the higher load capacity. Expensive modifications to the fabrication and assembly tooling, as well as new certification testing, would be required.

The advanced analysis methodology was validated by successfully predicting the results of the original step lap joint element test data available on the F/A-18E/F. The validated methodology was then used to model the current step lap joint design under the higher 9g loads.



Stress Check Analysis

The results showed a small positive margin, eliminating the need for any redesign efforts.

The improved analysis software and design handbook are now in widespread use by U.S. aircraft primes on aircraft including the F-22, F-18, UCAV, and Joint Strike Fighter.

Expected Benefits:

The application of the SIFT methodology on the F/A-18E/F eliminated the need to redesign the step lap joint, create new drawings, and modify or replace the fabrication and assembly tooling. This resulted in an estimated cost avoidance of $2.1 million. Also, the need for static testing was eliminated (only fatigue testing is needed), leading to significant additional savings not yet quantified.

TIME LINE / MILESTONES

Start Date: January 1998
End Date: August 2001

FUNDING

Air Force: $0.5M
Industry: $0.5M

PARTICIPANTS

Boeing
Lockheed Martin
Northrop Grumman