Air Force SBIR/STTR

Air Force SBIR/STTR Transition Story

Transition

STTR Topic Number:
AF 95-T-002

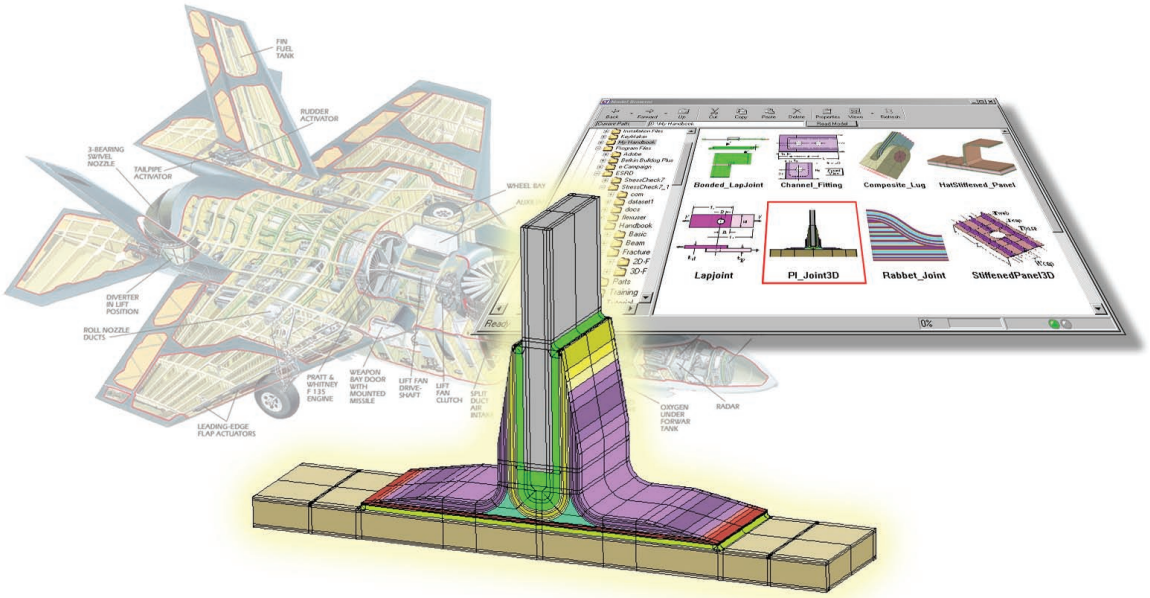
STTR Phase I Contract Number:
F49620-95-C-0070

STTR Phase II Contract Number:
F49620-97-C-0045

STTR University and Company:
Center for Computational Mechanics, Washington University, in conjunction with Engineering Software Research and Development, Inc., St. Louis, MO

AF Project Office:
AFRL/ML, Wright-Patterson AFB, OH

An example of Air Force supported SBIR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.



Structural Analysis Software Tool

Transitions Across DoD and the Commercial Marketplace

- An advanced modeling and analysis tool for complex composite structures is generating benefits across the aerospace industrial base. StressCheck™ is today widely viewed as the next-generation composite joint strength tool.
- Through industry innovation and a collaborative application of AFOSR Small Business Technology Transfer Program (STTR), Navy SBIR and Air Force/Navy ManTech efforts, these tools were developed, matured, validated and are being transitioned to the F-35 and other advanced weapon system and development programs.

PA # AFRL/WS06-2354

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Air Force Requirement

The Air Force and industry needed to develop improved analysis tools to support the timely analysis of bonded/cocured joints and IRC (International Residential Code) structures including detailed stress analysis and failure prediction. Conventional methods for analyzing bonded joints, such as the widely used A4EI code, are limited in their capabilities and accuracy. A4EI, for instance, is only applicable to adhesive failures in shear-loaded joints and does not account for peel stresses or for potential adherend failures. To date, the only alternative to these limitations has been to develop detailed finite element models of a joint. This approach is time consuming and requires great skill and care by the analyst to ensure stresses and strains in critical locations of the joint are properly quantified. Small errors in modeling can lead to substantial errors in joint performance prediction.

SBIR/STTR Technology

In 1995 the Air Force Office of Scientific Research (AFOSR) awarded a Phase I to the Center for Computational Mechanics of Washington University (WU) in conjunction with Engineering Software Research and Development, Inc. (ESRD) to develop a stress/failure analysis software for multi-material interfaces. This initial effort was successful and was followed by a Phase II STTR award in 1997. From 1997-2006, the Composites Affordability Initiative (CAI), funded by ManTech and industry, recognized that the StressCheck™ finite element software for composites analysis could fill the gap needed for a detailed interlaminar stress/strain analysis tool. The industry/government team provided input to ESRD on essential capabilities required by industry. Follow-on efforts were funded to enhance the capabilities of this software and to validate the enhancements.

The results showed a significant improvement in the accuracy of bonded and co-cured joint strength prediction capabilities. This advanced methodology was demonstrated on the F/A-18E/F bonded wing root step lap joint (primary attachment point of the wing to the fuselage) resulting in significant cost avoidance. Through these interrelated activities ESRD has produced and CAI has validated a software tool that is more accurate and that has overcome the traditional limitations for the analysis of complex composite structures including bonded joints.

The handbook functionality of StressCheck™ allows skilled engineers to develop reusable models of typical joints. These joints include single lap shear, double lap shear, scarfed lap shear, and step lap joints for in-plane loading as well as a 'Pi' and back-to-back angle joints for out-of-plane loading. These handbooks require the user to simply input the joint information including materials and joint dimensions. StressCheck™ automatically adjusts the model, calculates the results, checks for problems in the new joint configuration, and even prepares files for additional analyses.

Transition Impact

Initially the F-35 program evaluated the use of this software tool to analyze inlet duct bonded assembly joints. As a result of the success with this initial application, the value of the StressCheck™ analysis tool has been recognized for stress analysis of complex composite structural details and the use of this software on the F-35 program has expanded.

This commercially available structural analysis tool is being used across the DoD and the commercial aircraft industry. For example, StressCheck™ is a standard tool at Boeing and is being used by Lockheed Martin on the F-35 and is being evaluated for Global Hawk. The increased confidence in analysis tools has the potential to minimize the amount of physical testing and their impact to cost and schedule. This software and associated handbooks are saving substantial cost and time across the industrial base. By reusing the existing finite element models, a typical joint analysis can be accomplished in seconds instead of hours. Also, the automatic error checking and automatic application of the best failure criteria for each potential failure mode substantially reduces the potential for errors. In essence, these handbook models have captured the knowledge of expert composite analysts so that it is automatically applied in future joint designs of advanced weapon systems.

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