Department of the Navy SBIR/STTR Transition Program

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Topic # N121-042

High-Fidelity Residual Strength and Life Prediction Tool for Adhesively Bonded Composite Structures

Global Engineering and Materials, Inc.

WHO

SYSCOM: NAVAIR

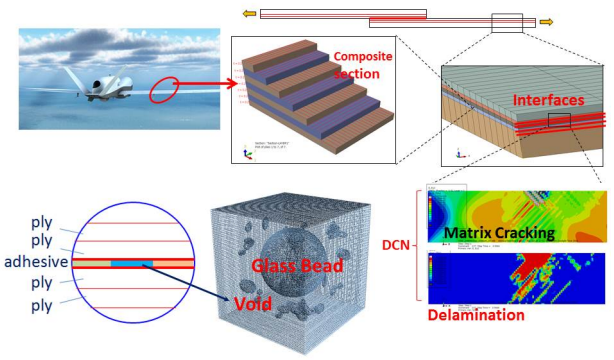
Sponsoring Program: Persistent Maritime Unmanned Aircraft Systems (PMA 262).

Transition Target: MQ-4C Triton (PMA 262)

TPOC:
(301)342-9351

Other transition opportunities: Advanced Integrated Composite Repair (Sikorsky). CH-53K (Sikorsky) helicopter and composite cuffs in H-1 (Bell Helicopter).

Notes: Figure description: Multi-physics based high fidelity strength and life prediction toolkit for composite bonded joint.



WHAT

Operational Need and Improvement: A high fidelity and mechanism-driven fatigue damage prediction tool for bonded composite structures is greatly needed for their operation under hot and wet conditions. It should have an accurate physical mapping between fabrication, environment, and loading parameters to their performance metrics.

Specifications Required: Navy is looking for durability assessment and improved design and certification of bonded composite structures based on damage tolerance; characterization of fabrication induced defects and material heterogeneity in a bondline; inclusion of initiation and propagation of various failure modes within the bondline, at the interfaces and in the adherends under fatigue loading; capturing the effects of environment driven material aging; and a user friendly and efficient solution module within a commercial finite element software.

Technology Developed: Under this effort, Global Engineering and Materials (GEM) is developing (1) A continuum shell and its phantom-paired cracked element for both Abaqus' implicit and explicit solver, (2) A multiscale solution process for characterization of bondline properties for a given distribution of fabrication induced bondline defects, and (3) A combined discrete and continuum damage modeling scheme for a large scale bonded structure.

Warfighter Value: A multi-physics based high fidelity damage prediction toolkit for bonded composite structures will provide optimized designs, increase the performance and reliability of Triton, helicopters, and other military vehicles.

WHEN

Contract Number: N68335-14-C-0045 **Ending on:** June 30, 2016

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Verification of phantom paired solid shell for characterization of matrix cracking	N/A	Performance verification using published analysis data	5	December 2014
Blind and recalibrated prediction for AF Tech Scout 1	N/A	Static strength and fatigue life prediction of open hole specimens	6	December 2014
Multiscale cohesive model for static and fatigue analysis	N/A	Demonstrated its applicability for an I-beam fabricated and tested by NIAR	5	February 2015
Capability extension for bonded and curved composite structures	Med	Tool validation using Sikorsky test data	5	September 2016

HOW

Projected Business Model: Initial use and software training for NAVAIR at Jacksonville and NSWCCD. GEM anticipates to obtain additional funding for capability extension and maturation of the technology and to perform capability demonstration for PMA-262, JSF, and PMA-261 program officers. The toolkit will be marketed to the premiers such as Northrop Grumman, Lockheed Martin, Boeing, and Sikorsky. The add-on software can be re-sold to Abaqus through the existing extensive Abaqus channels as well as through other potential software vendors.

Company Objectives: Global Engineering and Materials (GEM) is seeking opportunity for DoD support from non-SBIR programs and licensing the bonded joint toolkit.

Potential Commercial Applications: This toolkit can also be used for the following applications: Design and certification of bonded composite structures such as composite fuselage, composite wing box, and helicopter rotor hub; Design and certification of composite patch repair of damaged composite and metallic structures; Implementation of a new damage tolerance rule for composites using analysis coupled with structural health monitoring; New fabrication and processing techniques for a bonded structure with a reduced level of defects

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