## Topic: N161-010

## Global Engineering Research and Technologies

Novel Method to Utilize Multi-scale Physics-based Technique for Crack Path Determination in Fiber-reinforced Composites

Global Engineering Research and Technologies (GERT) has developed a state-of-the-art simulation tool that is capable of predicting initiation of matrix cracking, fiber breakage and delamination as well as their propagation paths in laminated composites under various loading conditions. GERT specializes in analytic method development towards prediction of deformation and failure of aerospace structural parts. Initial targeted platforms include PMA 275 and V-22 Osprey. There is no known existing analysis capability that can predict all possible failure modes in composites. GERT has so far developed an analysis capability to determine accurate stress and deformation fields in the presence of a cracks. The ultimate goal is to implement this technology into government and prime contractor production cycles as a failure analysis step that is necessary for certification.

Technology Category Alignment: Modeling, Simulation & Test Infrastructure

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## Department of the Navy SBIR/STTR Transition Program

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#### NAVAIR 2018-721

## WHO

SYSCOM: NAVAIR

Sponsoring Program: PMA 275

Transition Target:

TPOC:

(301)342-0297 Other transition opportunities:



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Global Engineering Research and Technologies' methodology has applications for Air Force, Army, MDA as well as DHS

Notes: Figure above depicts displacement in x-direction under compression in a [60/0]60]3s laminate after failure

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## WHAT

**Operational Need and Improvement:** As composites with superior features are increasingly replacing traditional metal parts in defense aerospace applications, accurate prediction of damage initiation and progression in aerospace structures is crucial, for failure of those structures could have catastrophic consequences and lead to loss of life and material. There is no existing analysis capability that can predict all possible failure modes in composites under multiaxial loading conditions and multiple-load paths. Experimental evaluation of damage that is not visible involves expensive specialized equipment, and may not be fully satisfactory in visualization of internal damage. Component level structural testing analysis of advanced composites is prohibitively expensive and time consuming. Instead, using robust and accurate computational tools complemented by experiments at key stages is a viable and cost effective option.

**Specifications Required:** Accurately predicting initiation of matrix cracking, fiber breakage and delamination as well as their propagation paths in laminated composites under static and cyclic loading conditions representative of the service conditions including the effects of moisture and temperature.

**Technology Developed:** A software tool to predict failure initiation, mode and propagation in fiberreinforced composites is being developed by Global Engineering Research and Technologies (GERT) using a peridynamic (PD) modeling approach. The tool and the methodology will accommodate quasistatic and fatigue type failures. The methodology will encompass the effects of features at different scales. Additionally, the method will take into account the effects of temperature and moisture on fracture of fiberreinforced composites

**Warfighter Value:** GERT's technology helps predict the structural integrity and service life of composite components under various loading conditions in various harsh environmental conditions.

## WHEN

Contract Number: N68335-18-C-0077

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Integration of macro-, meso- and micro- scale analysis in GERT software and ANSYS framework	Low	Analytical verification	4	November 2018
Formulation of a Peridynamics fatigue model for constant and variable amplitude loads	Low	Analytical verification	4	January 2019
Integration of Peridynamics with isogeometric analysis	Low	Validation/verification against available data	4	January 2019
Implementation of the Peridynamics fatigue model in a stand-alone GERT software and ANSYS	Low	Beta-testing	5	December 2019
Implementation of the Peridynamics with isogeometric analysis in GERT software and in ANSYS framework	Low	Beta-testing	5	June 2020
Technology demonstration - Peridynamics interfaced with ANSYS	Low	Beta-testing	5	January 2021

# HOW

**Projected Business Model:** License the software to government agencies as well as the prime contractors. Integration of GERT's technology into existing software provided by prime integrators.

**Company Objectives:** Develop a simulation tool that is the hallmark of predictive tools in the prediction of crack initiation and propagation in composite structures under general loading and environmental conditions.

**Potential Commercial Applications:** Prediction of failure initiation and propagation of composite parts in multiple industries including aerospace, electronics and nuclear.