Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2018-660

Topic # N151-009
Novel Isogeometric Analysis Based Automation of High-Fidelity Finite Element Analysis Model Creation from Computer Aided Design
Global Engineering and Materials, Inc.

WHO

SYSCOM: NAVAIR

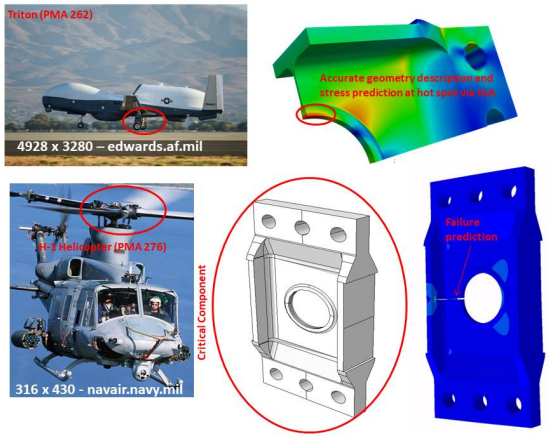
Sponsoring Program: Persistent Maritime Unmanned Aircraft Systems (PMA 262)

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

TPOC:
(301)342-8166

Other transition opportunities: H-1 Light Attack Helicopter (PMA 276); Optimization of structural design and repair using novel process such as 3D printing, additive manufacturing, and auto placement of fibers for a curved composite structures

Notes: An isogeometric analysis tool for an accurate description of a complex geometry, reliable 3D stress prediction, and damage initiation and propagation prediction. H-1 Image courtesy of US Navy and Triton image courtesy of US Air Force.



WHAT

Operational Need and Improvement: A high precision geometric description and an accurate three-dimension stress and failure prediction tool for a complex structural component is needed. It should fill the current technology gap in all existing commercial finite element software using distinct basis functions for geometry characterization and finite element mesh generation for structural response prediction. Navy is looking for an efficient design-through-analysis platform for an accelerated insertion of novel material systems, advanced structures, and repair and sustainment methods using additive manufacturing and 3D printing technologies.The developed technology must enable the Navy to perform rapid design iteration and optimization across a wider spectrum in terms of selection of geometries, mass/density distributions, engineered multiphase materials, and fabrication processes.

Specifications Required: The toolkit shall be able to model with preserved geometry from a Computer Aided Design (CAD) model followed by performing an accurate 3D stress prediction for a complex geometry with structural discontinuities.The system should provide a parameterized geometry for an efficient shape and geometry optimization.The resulting tool should reduce, if not eliminate time associated with preparation of the finite element model for a complex geometry in the current serial design-analysis approach followed by prediction of damage initiation and failure prediction.

Technology Developed: An isogeometric analysis toolkit for Abaqus (IGAFA) is developed for a high-fidelity finite element analysis (FEA) model creation as well as response and failure prediction of metallic and composite structures. IGAFA will create an analysis model with preserved geometry from a CAD model based on novel methods developed by Carnegie Mellon University (CMU) followed by performing an accurate 3D stress prediction for a complex geometry with structural discontinuities. IGAFA features include: selection of a geometry model, surface and volumetric T-spline construction, FEA and failure prediction, post-processing, and design alternation. In addition, IGAFA can be integrated with simulation tools used for additive manufacturing, 3D printing, or auto placement of fibers for a curved composite structure.

Warfighter Value: IGAFA provides added capabilities for efficient modeling, accurate prediction, and seamless integration with a CAD model can greatly reduce the time and cost for design iterations, certification and repair.

WHEN

Contract Number: N68335-17-C-0196 **Ending on:** July 15, 2020

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Generation of a volumetric T-spline for selected 3D geometries from their CAD models	N/A	Model generation using NAVAIR's benchmark example	4	June 2018
Module integration for IGAFA toolkit with its demo at component level	N/A	Toolkit demo for accurate 3D stress prediction	4	July 2018
Automation and T-spline description for a complex geometry at structural level	Low	Model generation using Triton structural component	5	June 2019
Integration with failure analysis module for damage prediction	Med	Failure prediction of a Triton structural component without and with repair	6	December 2019
Capability extension for shell element for characterization of a large scale structure	Med	Response and failure prediction using a local and global coupling	5	August 2020

HOW

Projected Business Model: Initial use and software training for NAVAIR at Patuxent River, MD and Jacksonville, FL. We anticipate to capture additional funding for capability extension and maturation of the technology and perform capability demonstration for PMA-262 and PMA-276 program officers. The toolkit will be marketed to primes such as Lockheed Martin, Northrop Grumman, Boeing, and Sikorsky. The add-on software can be re-sold to Abaqus through the exiting extensive Abaqus channels as well as through other potential software vendors.

Company Objectives: GEM along with its team member (CMU) is seeking opportunity for DoD support from non-SBIR programs or Phase III programs and licensing the IGAFA toolkit.

Potential Commercial Applications: This toolkit can also be used for the following applications: Design and certification of Triton structures such as landing gear, fuselage, composite wing box, and helicopter rotor hub; Design and certification of composite patch repair of damaged components and metallic structures; performance of an optimal design using new design parameters; New fabrication and processing techniques using 3D printing and additive manufacturing.

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