Topic: N141-032

ATA Engineering, Inc.

Simulation of Mechanical System Kinematic Operation Subsequent to High Intensity Loading

ATA Engineering's computational analysis methods enable prediction of post-damage kinematic operation of critical shipboard mechanisms – specifically, whether submarine hatches, scuttles, and watertight doors will still operate after experiencing shock damage. ATA is an employee-owned engineering services company providing solutions in the design, analysis, and testing of complex mechanical products. We developed the technology to aid design of future submarines (e.g., OHIO Replacement Class) and qualification of equipment for existing ships by reducing the reliance on costly underwater explosion (UNDEX) testing. ATA's approach leverages a commercially available finite element analysis (FEA) tool, Abaqus, and utilizes machine learning techniques for efficiently evaluating a large number of possible damage permutations. Current efforts involve validation through correlation with laboratory experiments. ATA seeks opportunities to support our customers' shock qualification efforts.

Technology Category Alignment:

Ground and Sea Platforms
Survivability
Modeling, Simulation & Test Infrastructure

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SYSCOM: NAVSEA
Contract: N00024-16-C-4006

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N00024-16-C-4006

Department of the Navy SBIR/STTR Transition Program

Statement A: Approved for Release. Distribution is unlimited.
NAVSEA #2016-0627

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ATA Engineering, Inc.

WHO

SYSCOM: NAVSEA

Sponsoring Program: PMS 397, OHIO Replacement Program Office

Transition Target:

TPOC:
(301)227-8874

Other transition opportunities:
PEO Ships

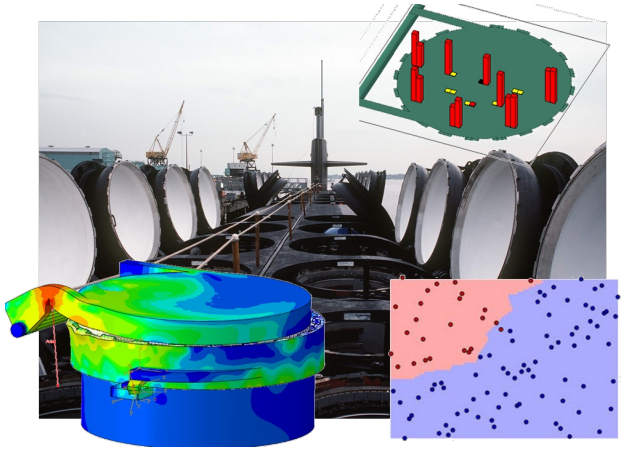

Photo: US Navy (DN-ST-82-01336), Graphics: ATA Engineering

WHAT

Operational Need and Improvement: The Navy currently uses a combination of shock testing and subsequent operational tests to verify operational integrity of shipboard mechanisms. This evaluation method can be prohibitively costly (>$10M) and time consuming, potentially requiring multiple test configurations or design iterations to validate the operational integrity of a system. It also provides limited insight into the reasons for operational failure of a system, requiring a great deal of dissection and extrapolation to understand the failure mechanisms using the limited instrumentation locations. For other systems that are prohibitively large, linear analytical methods, such as the dynamic design analysis method (DDAM) or transient shock analysis, are used to evaluate structural integrity; however, structural integrity is not necessarily a good predictor of operational effectiveness.

Specifications Required: N/A

Technology Developed: ATA is developing computational analysis methods for the prediction of post-damage kinematic operation of critical shipboard mechanisms - in particular, to determine whether submarine hatches, scuttles, and watertight doors will still operate after enduring explosive shock damage. ATA's approach leverages a commercially available finite element analysis (FEA) tool, Abaqus, and utilizes stochastic techniques to provide a means for efficiently evaluating a large number of possible damage permutations. In addition to advanced modeling techniques for contact and friction, the technology employs machine learning algorithms to serve as extremely fast-running (<< 1 sec) surrogates for large (+10M degree of freedom) FE models to enable hundreds or thousands of simulations to be performed in a matter of minutes or hours, rather than weeks or months for a comparable number of FE simulations.

Warfighter Value: These methods are intended to supplement and reduce the reliance on expensive underwater explosion (UNDEX) testing in qualifying mechanical designs. Their aim is to achieve (1) lower costs to shock certify critical mechanisms, (2) better understanding of post-damage operational effectiveness, (3) probabilistic views of operational effectiveness across range of damage states, and (4) accurate assessment of shock worthiness earlier in the design process.

WHEN

Contract Number: N00024-16-C-4006 **Ending on:** December 17, 2017

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Physics-level simulation	Low	Correlation of simulation and laboratory experimental results	4	November 2016
Component-level simulation	Med	Correlation of simulation and laboratory experimental results	5	March 2017
System-level simulation	Med	Demonstration of feasibility	6	December 2017

HOW

Projected Business Model: ATA plans to commercialize the modeling and simulation tools developed in this project through a multi-pronged approach involving sales of (1) engineering analysis consulting services, (2) training and other support activities, and (3) a customized Abaqus add-on software product. ATA will equip our engineering staff with the technology to enhance the company's capabilities in providing design, analysis, and simulation solutions for our customers and the development of their mechanical products.

Company Objectives: ATA seeks a role as a design and engineering resource for shipyards, prime contractors, and their suppliers developing and qualifying shipboard mechanical systems. In particular, we believe the technology arising from this project will provide significant value during the engineering and qualification of components aboard the forthcoming Ohio-class Replacement, such as the Common Missile Compartment (CMC), which is already being designed and prototyped.

Potential Commercial Applications: Industries that will benefit from the proposed technology include those that develop products for shock environments that otherwise require extensive testing for certification. A key example is the ship and submarine building industry, where systems are designed to maintain combat readiness even in the event of underwater explosion. ATA's validated kinematic simulation framework will allow engineers to evaluate a multitude of post-event mechanical scenarios for hull, equipment, machinery, and platform damage. Similar opportunities exist in other industries, such as automobiles and aircraft, where complex components are subject to high intensity loading.

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