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ATA Engineering: Modernizing Navy High-Speed Flight Systems

By Julie Scuderi

Navy reentry vehicles, such as those found on the Trident II Strategic Weapon System (SWS), must withstand extreme heat and pressure in the hypersonic environment when reentering the atmosphere. This necessitates a thermal protection system (TPS) constructed with carbon-carbon (C/C) composites on the outer surface of the vehicle to control erosion and minimize heat transmission to the underlying structure.

When the Navy's Strategic Systems Program (Navy SSP) sought a solution to qualify and certify new C/C materials for use in Navy missions, San Diego-based ATA Engineering, Inc. (ATA) accepted the challenge with a Small Business Innovation Research (SBIR) award.

C/C composites are one of the only materials suitable for thermal protection systems. The time-intensive manufacturing processes infuse carbon fibers with a carbon matrix to create a material able to survive these extreme conditions.

There are very few companies globally that manufacture C/C composites. They are difficult and expensive to build, and many times the component materials become environmentally disallowed, vendors cease producing them, or they become otherwise unavailable. The next generation of C/C composites promises shorter lead times and reduced costs, but a variety of hurdles still exist for going to market with these exotic materials.

"What the Navy wanted was innovation in bringing these materials to market quickly," explains Joshua Davis, president of ATA. "The old way of testing materials was archaic and relied on old software programs and historical data. It could take hundreds of thousands of dollars to qualify a new candidate material due to the extreme high-temperature ground test environments needed to replicate the conditions. We aimed to modernize how these materials were simulated by leveraging advances in computational analysis technologies. We wanted to characterize materials virtually with limited test data, to get insight before committing the expense of a comprehensive qualification program."

The project, titled Non-Linear Behavior Models for Design of Carbon-Carbon Composite Components, made its way through Phase I and II SBIRs, and evolved through the Navy's SBIR/STTR Transition Program (Navy STP). In addition to this Navy investment, Army and Air Force SBIR projects have contributed to the maturation and validation of COMPAS, which leverages both physics-based finite-element modeling and machine learning techniques in novel ways to model C/C materials. The software includes two process flows: one for correlating a nonlinear material model to coupon-level test data, and another for performing progressive failure analysis at a component/ structural level using the test-correlated material model.

COMPAS provides the engineer with reliable material model parameters even when comprehensive characterization data is unavailable. This capability helps to accelerate the adoption of new material systems that enable more lightweight and capable TPS designs.

"The Navy STP gave us the tools and information

The Navy's Trident II Strategic Weapon System contains a thermal protection system that must withstand extreme heat and pressure when reentering the atmosphere. ATA Engineering's SBIR-derived technology helps the Navy qualify and certify new materials to achieve this goal.

we needed to determine what use cases end users desired in the software, and what validation and verification milestones we needed to hit to apply COMPAS to real-world missions," says Davis. "It also allowed us to assess the market and explore other transition opportunities in different sectors, such as space exploration."

Navy SSP awarded ATA a Phase III contract under the Rapid Innovation Fund (RIF) worth nearly $3M to continue the development of COMPAS. ATA is currently in its second year of the Phase III project and ATA is focusing on adapting the framework to new families of materials within the Navy's high-speed flight systems. The work also includes extending COMPAS' capability to dynamic environments and investigating other conditions and environmental factors such as severe thermal gradients.

Looking to the future, the need for this toolset will be paramount as the Navy modernizes its reentry systems, replaces its existing systems, and fields new hypersonic weapon systems. As those efforts unfold, ATA, which is a 100% employee-owned company, hopes to support them with both software and engineering services enabled by COMPAS. As Davis summarizes, "It's all about reducing the cost and schedule needed to bring these materials to flight by employing modeling and simulation to do it in a more informed way."

For more information about the company, visit ATA's website at http://www.ata-e.com/