BRINGING IN THE REINFORCEMENTS

ORIGINATING TECHNOLOGY/ NASA CONTRIBUTION

What do NASA and ballistics have in common? More than the average person may know. Everyday, millions of Americans drive in vehicles, cross over bridges, and fly in airplanes without knowing just how important NASA's role in studying ballistics is in making these actions viable and safe for them.

At Glenn Research Center's Ballistic Impact Facility, NASA scientists and engineers study the dynamics of high-speed projectiles and their impact on targets to create materials and structures that are smarter, lighter, and stronger. By applying the science of ballistics to new developments, these researchers are taking major steps in preventing catastrophic events. The Ballistic Impact Facility's main features are a 40-foot-long gas gun that can launch projectiles at speeds over 1,000 miles per hour and high-speed cameras that can capture up to 250 million images per second.

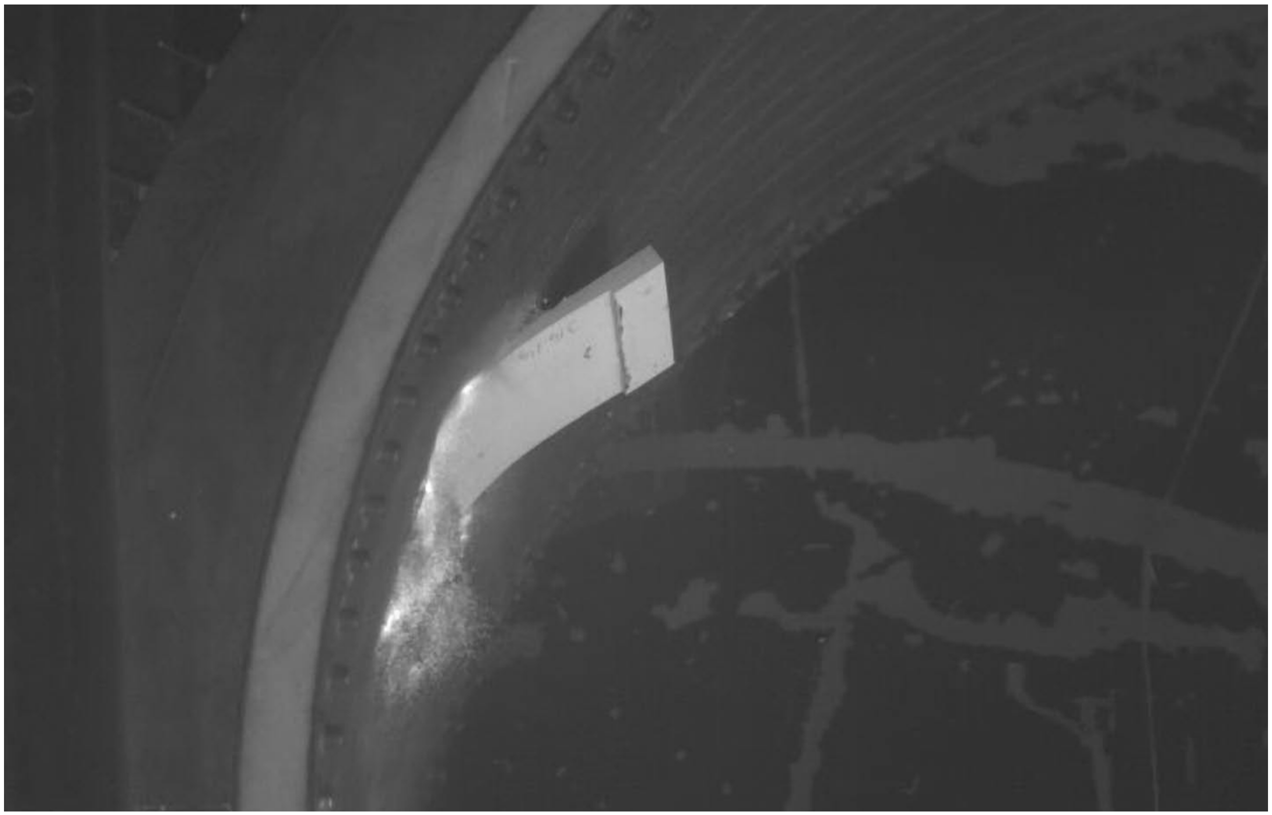
"The whole idea is to watch the impact and see how the structures impacted by the projectiles behave," says Dale Hopkins, a structures engineer and team leader for the facility. "It's not just whether they survive, but how they deform and fail."

One of the facility's main responsibilities is testing new concepts for aircraft engine housings to ensure they are capable of withstanding severe forces caused by fragments of rotating components that unexpectedly fail, for example, due to ingestion of foreign object debris such as hail or birds. Adequate engine housings are critical to reducing the risks of airplane damage and passenger injury.

On the ground, Glenn's ballistic testing is benefiting transportation and industry, thanks to a company named WebCore Technologies, Inc.

PARTNERSHIP

Based in Dayton, Ohio, WebCore Technologies utilized the Ballistic Impact Facility as well as other NASA resources to develop and commercialize its fiber-reinforced foam technology. Through prior experience with NASA personnel who participated in the "Consortium for the Design and Analysis of Composite Materials," the Great Lakes Industrial Technology Center (GLITeC)—Glenn's Regional Technology Transfer Center committed to providing commercialization assistance to Northeast Ohio companies—identified the expertise WebCore Technologies would need to invent a commercial product. In 2001, GLITeC facilitated a meeting between the company and Glenn, followed by a tour of the Ballistic Impact Facility. The two parties agreed to work together, using the ballistic facility to test samples of the product-to-be. GLITeC defined the scope of work in a simplified technology transfer agreement that required the commitment of less than $25,000 in Glenn resources, without special liability or intellectual property considerations. This agreement immediately helped to open the doors for WebCore Technologies to obtain $1.2 million in additional funding through **Small Business Innovation Research (SBIR)** contracts with Glenn and the U.S. Air Force.



High-speed photography from the Ballistic Impact Facility at NASA's Glenn Research Center reveals that a simulated fan case constructed with the TYCOR® material exhibits high stiffness and excellent damage localization during an impact event.

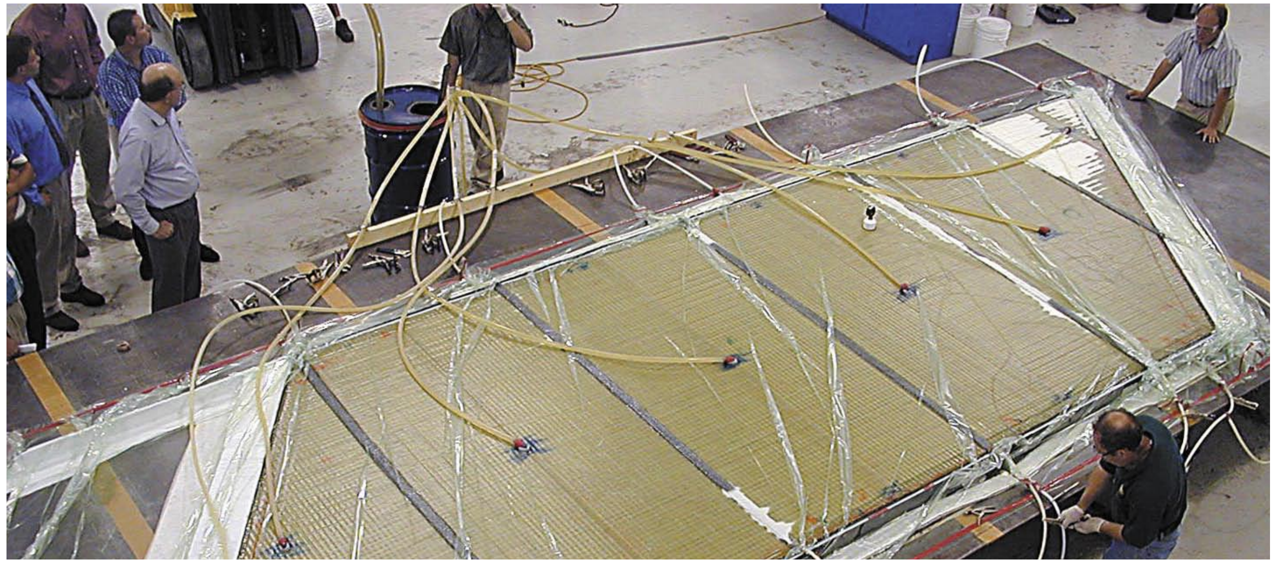
Additionally, WebCore Technologies received a NASA Glenn Garrett Morgan Assistance Award to establish a comprehensive sales and marketing force for the fiber-reinforced product. The award, intended for small, minority- or women-owned companies in the "Great Lakes" states as well as in New York, North Carolina, and Georgia, also entitled WebCore Technologies to seek help from the Garrett Morgan staff in solving a particular technical problem that arose during product development.

PRODUCT OUTCOME

The TYCOR® fiber-reinforced foam composite is WebCore Technologies' answer for a lightweight, low-cost sandwich panel that offers superior structural performance to aerospace, defense, construction, transportation, marine, and industrial markets. TYCOR consists of a foam core that is covered with fabric skins and then stitched with reinforcing fibers. When the skins and fibers are impregnated with resin, the result is a very strong, damage-resistant composite system.

The core manufacturing process integrates porous fiberglass or carbon fiber reinforcements in a three-dimensional architecture, in the form of structural "webs." The porous reinforcements act as resin flow channels that are easily controllable during resin infusion. The core process delivers a high degree of design flexibility using different types of foam and fiber, which are tailored to meet the functional requirements and cost targets for specific applications.

The key features of TYCOR include high-shear strength and stiffness, and high-tensile pullout strength coupled with excellent damage tolerance. To demonstrate TYCOR's shear strength and stiffness characteristics, WebCore Technologies subjected the fiber-reinforced foam to head-to-head testing against a balsa-cored panel of identical density, in a demanding U.S. Navy ship structural application. The panels were 5 inches thick, constructed with



Shown above is an example of the WebCore Infusion Process (5 minutes after the start of infusion) that was used to fabricate a 20-foot-long, 8-foot-wide, 3-inch-thick bridge deck panel. The panel, comprised of TYCOR® core preforms, fiberglass skins, and epoxy vinyl ester resin, was fully infused in less than 10 minutes and had a final panel weight of 1,200 pounds.

4.5-inch cores, quarter-inch-thick glass fabric facings, and vinyl ester resin. The test results showed that the TYCOR panel was almost twice as strong as the balsa panel. The balsa panel also experienced abrupt failure under shear stress, whereas the TYCOR panel experienced only gradual failure. Follow-on work with the Navy led to a watertight composite door for Navy ships that offers a 50-percent weight reduction over existing watertight doors.

TYCOR panels were used in the first composite bridge deck installed on a Federal property: the Hebble Creek bridge site located at Wright-Patterson Air Force Base. WebCore Technologies designed, fabricated, tested, and installed four 8-feet by 32-feet composite panels to form the bridge deck. The deck was tested for over 250,000 load cycles to simulate over 50 years of traffic, successfully showing TYCOR's long-term durability.

The technology is now a part of a lightweight airfield matting system being developed to replace the aluminum matting currently used in temporary runways, taxiways, aircraft parking areas, and other surfacing applications. WebCore Technologies is even exploring the possibility of replacing traditional manhole covers with fiber-reinforced covers that could better handle load-bearing vehicles.

Further, TYCOR cores and sandwich panels can be used for various interior and exterior components of commercial aircraft. Potential interior applications include floors, doors, bulkheads, seats, and luggage bins. Potential exterior applications include control surfaces, landing gear doors, access doors, fairings, radomes, and fuselage panels. NASA, too, can benefit from TYCOR, with potential applications for rocket fairings, payload adapters, cryogenic tanks, and structural members. WebCore Technologies is in the midst of completing Phase II of its SBIR contract with Glenn to bring these applications—and others—closer to reality.

TYCOR® is a registered trademark of WebCore Technologies, Inc.