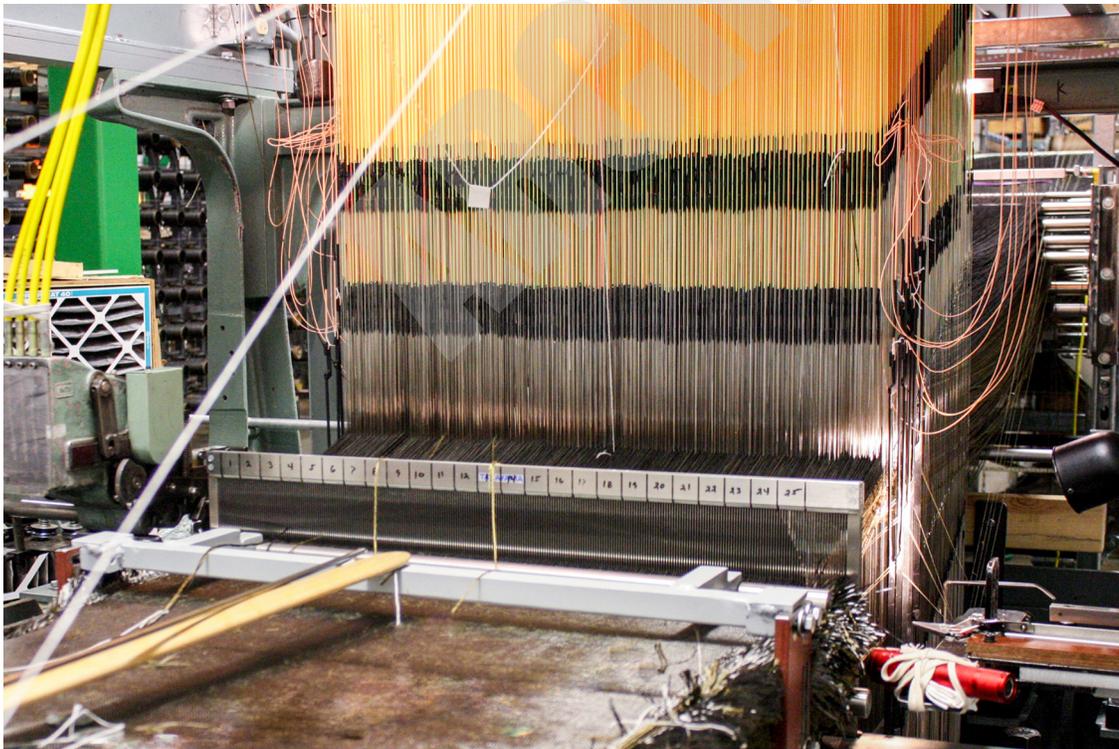


# Space Technology Game Changing Development Heat Shield for Extreme Entry Environment Technology (HEEET)

The Heat Shield for Extreme Entry Environment Technology (HEEET) project seeks to mature a game changing Woven Thermal Protection System (TPS) technology to enable in situ robotic science missions recommended by the NASA Research Council Planetary Science Decadal Survey committee. Recommended science missions include Venus probes and landers; Saturn and Uranus probes; and high-speed sample return missions.

Currently, these missions are limited to the use of heritage materials such as carbon phenolic (CP) as their only TPS solution. Due to its inherent properties, heritage CP constrains the mission, and in the long term, poses significant sustainability challenges.

The goal of HEEET is to develop a woven TPS technology to technology readiness level (TRL) 5/6 by 2018 that will provide an alternate TPS



*HEEET material for future missions will be woven with a new 24-inch loom that is capable of weaving dual layer HEEET material 24 inches wide at thicknesses of 2 inches and greater. The picture above shows the loom under construction as of November 2016.*

solution for these missions. The tailorable woven TPS will reduce entry loads and significantly reduce heat shield mass by 30 to 40 percent for extreme entry environments missions.

Woven TPS is a science enabler that will allow for a high return on investments made by both NASA's Space Technology Mission Directorate and Science Mission Directorate.

The HEEET woven TPS architecture consists of a high-density all-carbon surface layer (designed to manage recession) below which is a lower density layer composed of a blended CP yarn (insulating layer to manage heat load). This woven architecture is then infused with a mid-density level of phenolic resin. A layer-to-layer weave is utilized in HEEET that mechanically interlocks the different layers together.

This dual-layer approach allows greater mass efficiency by limiting the thickness of the high-density outer layer. By varying the thicknesses of the different layers, the mass can be optimized for a given mission. To date, the HEEET materials have been tested to conditions of ~6000 W/cm<sup>2</sup> heat flux and five atmospheres of pressure and have shown excellent performance.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit <http://gameon.nasa.gov/>



*Heat shield for Saturn or Venus missions.*



*Nose region – woven preform molded and resin infused at Fiber Materials Inc.*

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