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# TECH BRIEFS®

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# 40<sup>th</sup> ANNIVERSARY



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# APPLICATION BRIEFS

## Simulation Software is Key to Orion's Heat-Shield Success

Tecplot 360 EX data visualization and analysis software  
Tecplot, Inc.  
Bellevue, WA  
800-763-7005  
www.tecplot.com

NASA chose Tecplot 360 EX for use in the design of the heat shield for the Orion spacecraft. Orion's heat shield, a protective blanket built with high-tech fibers and ceramics, is crucial to mission success. The outer layer of the heat shield is designed to burn away as it heats up during re-entry into the atmosphere, thus maintaining the integrity of the inner layer and helping to ensure the survivability of the spacecraft.

To predict temperature and airflow around the heat shield during re-entry, a team of engineers analyzed heat-shield materials in NASA Ames' Arc Jet wind-tunnel, and then compared the results with those generated by CFD (computational fluid dynamics) simulations. They then used Tecplot 360 EX as a post-processor to analyze, visualize, and understand the CFD results.

The Tecplot software helped engineers visualize the simulations generated by two NASA-developed CFD solvers: DPLR, or Data Parallel Line Relaxation; and LAURA, or Langley Aerothermodynamic Upwind Relaxation Algorithm. The DPLR and LAURA tools simulate the physics of the extreme heat generated when an object enters Earth's atmosphere.

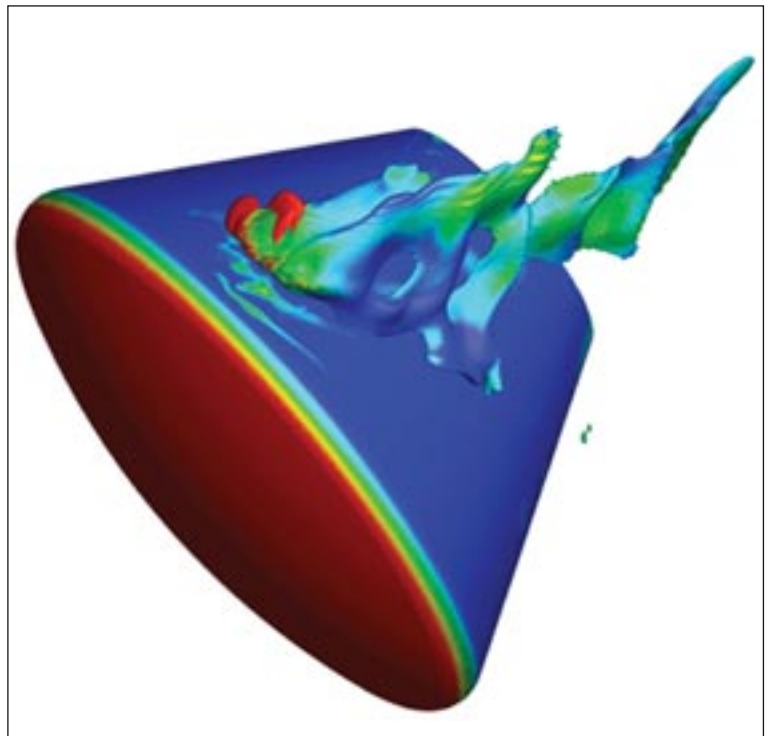
The NASA team ran about 2,000 DPLR and LAURA simulations and analyzed those simulations with the Tecplot software. The simulations tell NASA how hot the heat shield surface will get when entering the atmosphere based on the known physics of friction of the molecules in the atmosphere flowing over the heat shield. The team knows from other testing at what temperature the heat shield will melt, so if the simulations show the temperature staying below that mark, they can safe-

ly predict that Orion will survive that part of the re-entry process.

NASA conducted the first test flight of the Orion Program late last year. If all goes according to plan, the Orion spacecraft will put humans on an asteroid by 2025, and on Mars in the 2030s.

Unmanned for its first test flight, Orion was designed and constructed to travel farther into space than any other spacecraft intended to carry humans, and through temperatures twice as hot as molten lava. The sole purpose of the flight was to test Orion's critical systems under real flight conditions. The next unmanned test flight of Orion is expected in late 2017 or early 2018.

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Simulation of roll jets interacting with the incoming flow using DPLR with an SST turbulence model. Temperature contours of the plume and on the vehicle's surface show potential heating augmentation on the aftbody of the Orion MPCV capsule. (NASA)

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Saint-Gobain Seals produced a cryogenic seal measuring more than six feet wide for NASA's Space Launch System (SLS) project. Although this launch system replaced the retired space shuttle, it was built using proven hardware from the space shuttle era and previous successful exploration programs, as well as cutting-edge tooling and manufacturing technology in order to reduce development time and cost. SLS' first mission, Exploration Mission 1 (EM-1), will go into space in late 2018, and uses Saint-Gobain seals.



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The evolved configuration development of the SLS will stand 384 feet tall, weigh 6.5 million pounds, and generate 9.2 million pounds of thrust for EM-1 at liftoff. The 22-day EM-1 mission will help confirm the integrated system performance of the SLS launch vehicle and unmanned Orion capsule as it travels a stable orbit beyond the Moon and returns to Earth. The mission will break the distance record reached by the most remote Apollo spacecraft, and then 30,000 miles farther out (275,000 total miles). The second SLS flight, Exploration Mission 2 (EM-2), will carry four astronauts beyond low Earth orbit for the first time since the Apollo 17 mission in 1972.

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