Computers in engineering

DSSP helps ensure NASA shuttle safety

Space travel will always be a gamble, but new approaches to safety such as digital shape sampling and processing (DSSP) are tilting the odds in NASA's favor.

"As taxpayers, you pay us to play the odds," said **NASA** Chief Michael Griffin last year before the July launch of Discovery mission STS-121. "It's called risk management."

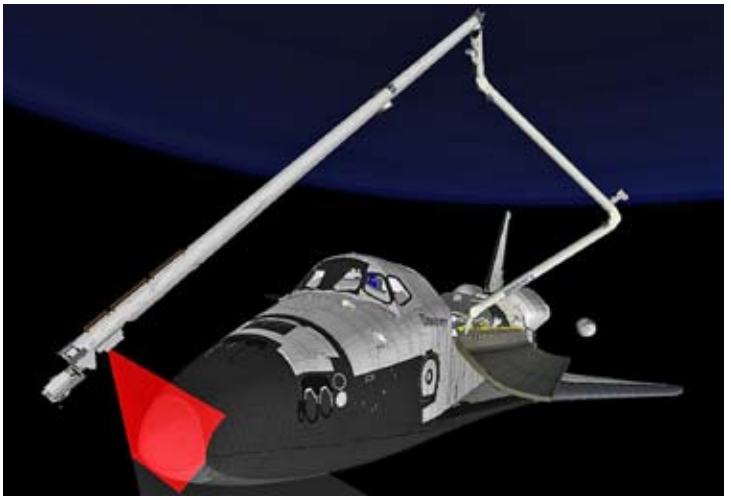
While acknowledging risk, NASA has made major leaps since the Columbia disaster in 2003 to make space travel safer. One of the biggest areas of improvement is using DSSP to detect, assess, and repair, if necessary, tile damage caused by foam particles dislodged from the shuttle and other flying debris.

Heat-resistant ceramic tiles that cover the underside of the shuttle fleet are part of the thermal protection system that shields the orbiter and its astronauts from the 2300°F heat faced during re-entry into the Earth's atmosphere.

DSSP, the process of automatically transforming physical objects into accurate 3-D digital models, was implemented for the first time in August 2005 for the initial Discovery mission. It since has become an integral part of NASA's safety strategy.

Geomagic Studio software provides the central technologies for NASA's implementation of DSSP. The software is used by major automotive, aerospace, and consumer product manufacturers worldwide to digitally re-create complex physical objects for mass customization, more accurate analysis and simulation, and digital inventory. NASA uses Geomagic Studio to automatically process 3-D data collected from a scanner while the shuttle is in flight.

The process of capturing and digitally re-creating tiles for the shuttle starts with a **Neptec** scanner mounted on a 50-ft-long extension of Discovery's robot arm. Neptec's Laser Camera System uses a synchronized scanning technique patented by the **National Research Council of Canada**. According to Neptec, it can detect a crack as small as half a millimeter, or twice the width of a standard business card, from as far away as 4 m. Unlike traditional cameras, it can operate without available light, a major consideration in space, where the sun rises and sets 16 times per day.



NEPTEC

Simulation of a Neptec system scanning the Discovery shuttle for cracks in the thermal protection system.

As the shuttle nears the space station for rendezvous, it rolls over to expose its underside. Video surveys and detailed 3-D scanning inspections are conducted during the approach and docking to determine damage to the tiles underneath the wings. Tile damage is part of space travel; 2-D video can pick up some of it, but the details are only discernible through 3-D analysis.

Scan data from the Neptec system is transmitted to NASA's **Johnson Space Center** in Houston, TX, where Geomagic Studio is used to process the data and create a 3-D model of damaged tiles via patented algorithms that speed surface generation and ensure quality for highly detailed models. Because of its high level of automation, Geomagic Studio requires very little training; a logical workflow enables users to maintain proficiency even if they do not work with the software on a daily basis, says the company.

The 3-D surface model created in Geomagic Studio is used by NASA engineers to assess the level of damage to the tiles. If the digital model indicates a safety threat, engineers create a toolpath to replicate the damage on an array of test tiles. The reproductions of the damaged tiles are tested in NASA's ArcJet facility to determine whether they can withstand the heat and stress of re-entry.

Shown is a digital reconstruction of tile damage automatically created in Geomagic Studio based on data captured from a Neptec scanner.

If damage is considered too extensive for safe re-entry, the situation could call for a spacewalk by astronauts to make the repair. In this case, the test tiles would be used to develop the step-by-step repair process. Fortunately, in-flight repair has not been necessary in Discovery flights to date, as analysis of scan data showed that damage was not severe enough to put the orbiter at risk during re-entry.

Rob Black, Engineer and Account Executive in charge of NASA projects for Geomagic, wrote this article for *Aerospace Engineering*.

Flowmaster releases aerospace-focused system simulation tool

At this month's Paris Air Show, **Flowmaster** will launch its first aerospace-dedicated software package, Flowmaster V7 Aerospace R1, for use in the design and manufacture of various types of aviation fluid systems.

Changes to the foundation of the Flowmaster software—switching from a flat-file to a more open sequel database—have enabled V7 to be more easily customized, allowing the company to create industry-specific programs for aerospace, automotive, and gas turbine industries. Each version will contain a catalog of industry-tailored components and allow users to build and customize their own component catalogs, leading to reduced project time, increased quality, and repeatability of initial designs.

"The benefit to these industry versions is not only are we tailoring some of our technical developments to them but also the user interface of Flowmaster in Version 7 because the database is much more configurable," said Jason Burke, Flowmaster Aerospace Product Manager. "Instead of having to get used to how Flowmaster works, Flowmaster can be configured to how [users] work and also how companies work."

When development began on the next version of Flowmaster three years ago, the company sought input from long-use customers, asking about their simulation goals and areas that could be addressed in future product versions.

"All of them really stressed being able to share data and share knowledge between the different groups and also their suppliers," Burke said. "And then also being able to customize the software to be able to fit within the way they work, in terms of the design process."

In addition to being able to create component catalogs, V7 Aerospace R1 is open enough to allow users to create their own components. "One of the new ways to customize a software, where companies are really interested in using it, is to be able to implement Flowmaster fit into the design process, whereas before you couldn't," Burke said.

Making the program accessible across a wide range of users with varying needs and skill levels was a goal of the Flowmaster development team. By bridging the gap between analysts, who design systems and are highly technical, and project managers and designers concerned with time-to-market, weight, and cost, productivity increases could result.

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