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ANALYTICAL GRAPHICS, INC.  
220 VALLEY CREEK BLVD.  
EXTON, PA 19341



## Shedding Light on Launch Windows

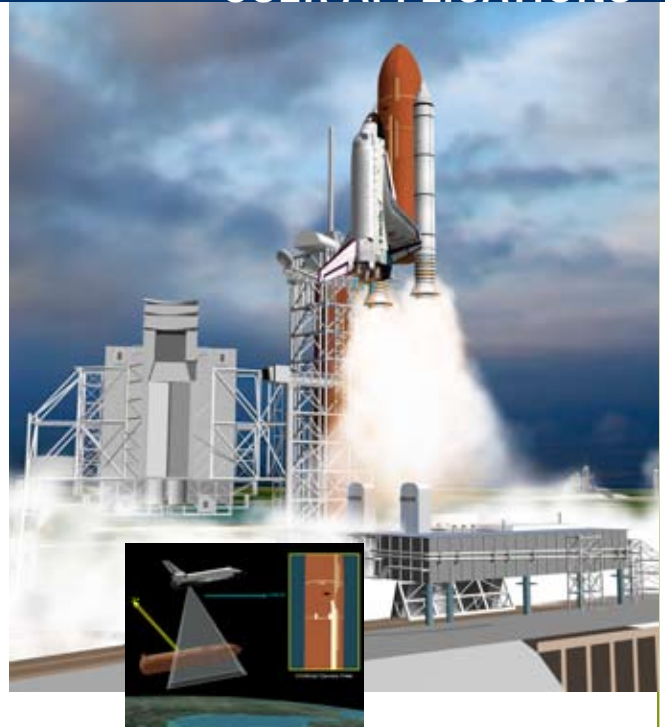
**NASA Used STK to Analyze  
Return to Flight Launch Dates  
Based on External Tank  
Photography**

THE SPACE SHUTTLE DISCOVERY (STS-114) IS SET TO blast off from Kennedy Space Center, FL, marking the return to flight for the Shuttle fleet following the loss of the Columbia in February 2003. STS-114's mission to the International Space Station (ISS) marks the first step in the U.S. Vision for Space Exploration and ends a two-year Shuttle hiatus during which NASA undertook an intensive agency-wide effort to make the fleet safer. The most significant return-to-flight work was performed on the 15-story, orange-colored external tank (ET), which was redesigned to eliminate debris from striking the spacecraft. Previously, the Columbia Accident Investigation Board had concluded a section of insulating foam that popped off the external tank had hit and created a hole in the leading edge of Columbia's left wing, contributing to the accident two years ago.

As part of NASA's efforts, engineers at Johnson Space Center in Houston used STK software to help determine launch windows that provide the best illumination for critical photography of the tank when it separates from the orbiter after ascent. In one study, engineers analyzed lighting conditions for the Shuttle orbiter's internally mounted umbilical-well movie and still cameras as well as for crew hand-held cameras. Together, these instruments serve as one of many imagery systems that will help experts on the ground assess ET performance and aid in determining if any debris, such as insulating foam generated during ascent, presents a hazard to the orbiter's thermal protection system. Imagery data is essential for engineering analysis since the tank is allowed to reenter the atmosphere and burn up after ascent.

The collected imagery will be downlinked in near real time and will be available as part of a suite of photo, video, and radar detection assets. To maximize the imagery available for engineering analysis, the first two return-to-flight missions will launch in daylight.

Surprisingly, selecting launch windows that maximize



data collection posed more challenges than expected. Finding days when sun angles are simultaneously optimal for all photography systems—ground cameras, on-board cameras, and crew-held cameras—proved difficult. Analysis showed that frequently on days when lighting at ET separation was optimal, lighting for the supplemental ET photography by the crew through the overhead window would be poor. This is due to the relative position changes of the orbiter and ET after they separate.

To study the options, NASA used STK to rapidly evaluate and visualize the general lighting conditions on the tank and to screen for acceptable launch dates. Using STK's 3-D visualization component, engineers created 3-D animations of the fields of view for the internally mounted umbilical-well cameras and the crew camera for various launch windows. These simulated photos were then passed to imagery analysts who evaluated whether critical ET components had acceptable lighting. NASA's experts also utilized STK animations to help determine the photography system that should take top priority in establishing the launch date. Ultimately, they chose to rely on the automatic on-board umbilical cameras as their first analysis tool, and to supplement the data from those cameras with the imagery gathered by the astronauts using hand-held cameras.

The final choices were run through NASA's legacy photo simulation tool to output highly detailed pictures to verify the results. From this analysis, several launch periods that have acceptable lighting for both ET separation and crew photography were established. In the event of a launch slip, maintaining good ET separation photography is a requirement. In addition, videos created with STK will be used as PC-based training tool for the astronauts who will be photographing the tank.

As NASA moves the Vision for Space Exploration forward, AGI will be watching and continuing its support of this vital initiative.▲