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Beyond the Clouds

Lockheed Martin Launch Team Uses STK as Eyes in the Sky

IT'S A CLEAR FEBRUARY DAY WHEN THE TITAN IV carrying Milstar II lifts off from Cape Canaveral. Everyone in the control room watches as smoke billows off the pad and the rocket clears the tower. Then as it cuts through the clouds and exits the atmosphere, all eyes shift to the STK 3-D animation running in real time beside the live camera coverage. There, viewers see what the human eye no longer can: every trigger event, including engine firings, antenna switching, and rocket stagings. At each key event—such as when the solid boosters are jettisoned or the payload fairing separates—applause breaks out around the control center.

"People can tell from the telemetry that the breakwires have tripped, but they want to actually see the payload fairing come off. With STK, they can," says Paul Engel. Engel is one of four Lockheed Martin Space Systems Company-Astronautics Operations software engineers who runs STK visualizations driven by live telemetry for Lockheed Martin Titan and Atlas launches from Cape Canaveral and Vandenberg Air Force Base in California.

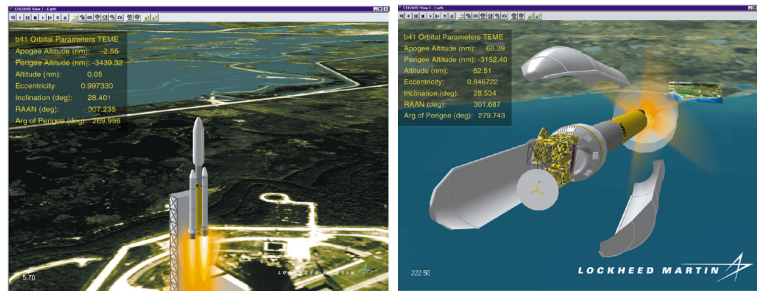
Last winter's Milstar II launch, which took the defense department's most sophisticated communications satellite into space, was just one of 24 successful launches that Engel and his colleagues Rod Mack, Jon Tattershall, and John Nakai have supported since 1998. For each mission, they use Lockheed Martin legacy software to sift through telemetry for key events and feed the essential data into STK's 3-D visualization component using the STK/Integration Module. The three-dimensional real-time animation that is created is then distributed to multiple locations around the U.S. with a mere one- to three-second delay.

"We generate animations at Denver [Astronautics Operations headquarters], Vandenberg AFB, and Cape Canaveral, providing Vandenberg-wide and Cape-wide distribution," Engel says. "From Denver we distribute it around the Denver Lockheed Martin campuses as well as to our Washington field office in Crystal City, VA. We have a distributed system with STK and telemetry coming in at many locations, so I can sit at the Cape and process data from Vandenberg and vice versa," Engel adds. "If the launch is classified, animations are generated and transmitted only to sites capable of handling classified information."

Through their efforts, Engel and his colleagues support mission directors, flight controllers, guidance and navigation personnel, as well as Lockheed Martin's cus-

tomers and Astronautics Operations upper management. The team provides a tangible asset for all involved: heightened situational awareness. "If you are not intimately involved with the mission details, it's hard to look at one-second attitude quaternions or yaw, pitch, and roll telemetry to get a feel for what the rocket is doing or how it's maneuvering," says Engel. "Position data is made up of three numbers; attitude data can be made up of four or nine, and they all change once a second. But when you see the movements on screen in 3D, your brain ingests the information instantaneously."

Engel and his colleagues rely on STK's visual cues to aid mission control's decision-making and to give valuable information to customers and managers not intimately involved with the launch. The team uses STK's head-up display to provide the corresponding telemetry to the 3-D images on screen. Along with that, they turn on vectors that show everything from the vehicle's position and atti-



tude relative to the Sun and Earth to where the vehicle's antennas are pointing in relationship to tracking and data relay satellites and ground stations. The team also runs an animation of the planned mission beside the actual event. Along with providing key information, the cues have the side effect of relieving tension.

"During an unusual maneuver, it's calming to know that the vehicle is doing what it should," Engel says. After a launch, the software engineers continue to use STK to show on-orbit operations, including deployment and spacecraft operations.

Launch day, however, is simply the culmination of nearly a year's worth of preparation. Nine months out, the group begins generating STK scenarios and outputs those as software animations and VHS movies that they use for launch planning, rehearsals, pre-launch verifications, and customer readiness reviews.

Later this year, they will support three launches in the span of a few weeks. The workload will be heavy, but to Engel and his colleagues, the effort is worth it. "Engineers still need the numbers, but the situational awareness they gain with STK is a major benefit," says Engel. "It's a key tool that helps with decision-making." ▲