Virtual *Cockpit* *Becomes* Reality

by Roger Roberts and Joanne Hale

IMAGINE what it would be like to fly an aircraft hundreds of miles an hour at low altitudes without the use of windows. Now imagine if scientists were able to replace each of the aircraft's windows with a real-time digital image of the aircraft's immediate surroundings. One group of JSC engineers has already taken the first steps in making that vision a reality.

NASA/Markowitz/Stafford JSC2004-00588

Members of the ACES team stand beside the ACES van as it prepares for testing at JSC's "Mars Yard."

The Advanced Cockpit Evaluation System (ACES) uses inexpensive desktop computers to produce live panoramic views of real-world environments. This synthetic view is created by using a combination of live video, advanced computer graphics and modern sensor technology.

On the outside, the ACES mobile command station appears standard in almost every respect. It resembles an average cargo van equipped with the most basic of options. But appearances can be deceiving.

"Sitting in the back of the van is like sitting in the cockpit of some sort of experimental aircraft," Jim Secor, ACES engineer, said. "Everything is there – a cockpit, controls and even windows. The only difference is our windows are actually monitors that look into a world where information is displayed across a continuous horizon."

ACES' view is achieved by blending live video with synthetic imagery sources such as satellite photos, heads-up displays and topographical imagery scans.

"If you depend solely on your eyes or video image to navigate, you will eventually find yourself in a situation where you are, in fact, flying blind," Jeff Fox, ACES team lead, said. "With ACES, if live video were to fail, then a synthetic virtual scene would be immediately available to maintain total situational awareness. Since ACES does not depend on line of sight to render its views, it can even be used in vehicles that have no windows at all."

ACES provides two ways to present the blend of video and synthetic imagery. The primary method allows images to be displayed on five flat-panel computer monitors. These monitors are located in the rear of the van and are arranged in a semicircle designed to mimic a forward field of view. The middle monitor displays live video while the remaining four monitors recreate the rest of the scene using computer graphics.

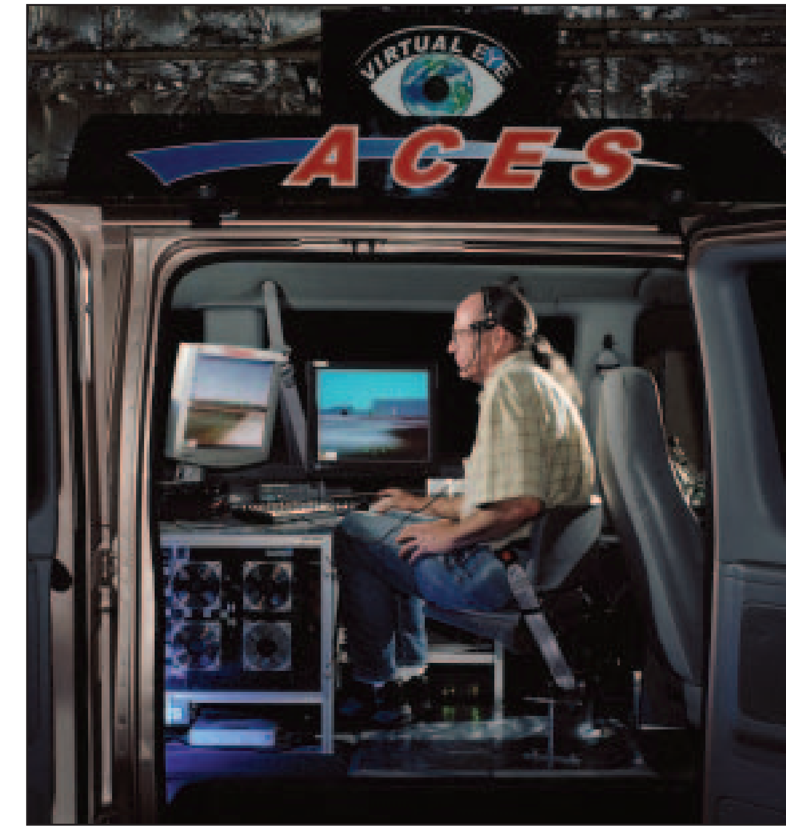
In addition to the monitor configuration, ACES also has a helmet-mounted display system that creates a digital view of reality.

"Inside the van there are seven state-of-the-art computers that work in parallel to process the sensor data to generate an immersive 3-D environment," Patrick Laport, ACES software integration engineer, said. "Basically, ACES makes you feel like you've stepped into the greatest video game of all time."

The capacity to present basic information such as speed and altitude on top of live video imagery is only the beginning of ACES' potential.

"We are currently working with the Federal Aviation Administration to design a system that will help pilots land both commercial and general aviation aircraft," Laport said. "Currently, pilots must use a combination of instrumentation and textual procedures to plan their final approach. With ACES, we can combine all necessary information into a single graphic interface that would give pilots a complete 3-D view of their current environment."

Recently, in the high deserts of Arizona, ACES' versatility proved useful in supporting the ongoing testing of NASA's prototype planetary rover, also known as the Science Crew Operations and Utility Testbed (SCOUT).



NASA/Markowitz/Stafford JSC2004-00589

Jim Secor, ACES engineer, oversees synthetic vision operations from inside the ACES van/mobile command station.

"Using the ACES mobile command station, our team was able to easily interface with and remotely control SCOUT in both day and nighttime operations," Fox said. "With only a few seconds' communication delay to the moon, the situational awareness provided by ACES may give future lunar rover pilots the vision necessary for enhanced real-time remote control from the Earth itself."

With the myriad of possibilities represented by the ACES project, Fox said he believes one attribute remains key in distinguishing it amongst its peers.

"ACES' main attribute lies in its relative affordability," Fox said. "While it's true other technologies currently emulate some of ACES' abilities, many of them are higher-priced systems. Since ACES is comprised almost entirely of off-the-shelf hardware, it maintains an adaptability factor that makes it ideal for exploring possibilities in a wide range of environments."

While Fox and his team continue to make advancements in ACES technology, the project remains in its infancy.

"Though it may be a while, the day is coming when ACES, and projects like it will become a part of everyday life," Coffman said. "In the future, cars, planes and spacecraft may all exist in a world where the options are limited only by our capacity to understand and create them. It's only a matter of time."

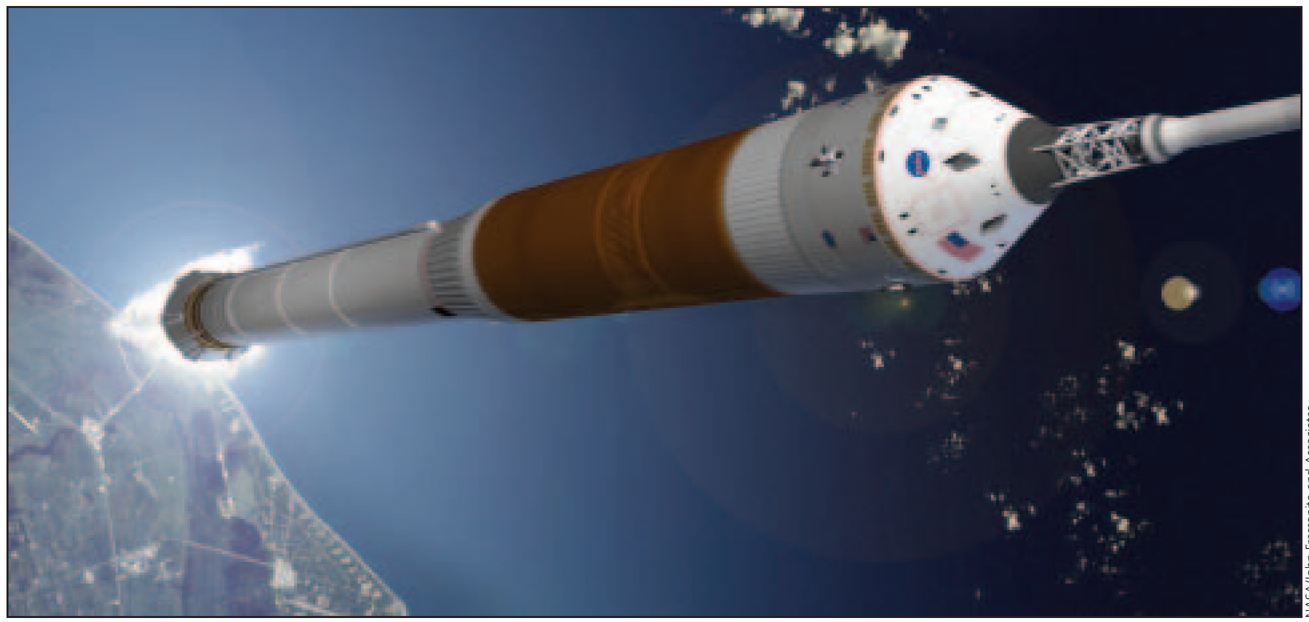
NASA/Markowitz JSC2005E38281

ACES mobile command station remotely controls SCOUT in the Mars-like environment of the Arizona desert.

Hello, stranger

NASA WILL REVISIT THE MOON WITH THE CREW EXPLORATION VEHICLE

by Catherine E. Borsché



Top: *The launch system devised for the next-generation spacecraft will use powerful, reliable shuttle propulsion elements already in existence. In this rendering, astronauts onboard the Crew Exploration Vehicle (CEV) launch into orbit on a rocket made up of a single shuttle-derived solid rocket booster, with a second stage powered by a shuttle main engine.* **Above:** *The CEV will not only be suited for missions to the moon and beyond; it will also be capable of delivering crews and supplies to the International Space Station. Here the CEV prepares to align and dock with the station.*

'Think of it as Apollo on steroids'

NASA Administrator Mike Griffin

For decades, the moon has been quietly orbiting the Earth, undisturbed since past visits from Apollo crews. But change will be forthcoming to the remote lunar destination – in the form of a new next-generation spacecraft.

On Sept. 19, NASA Administrator Michael Griffin released the results of the agency's exploration architecture study, a blueprint for the next-generation spacecraft. This spacecraft will use an improved, blunt-body capsule, much like the shape of the Apollo spacecraft, but with more than three times the volume of the Apollo capsules. However, even if it looks like an ordinary capsule, this new vehicle will have many more capabilities.

"It's a significant advancement over Apollo. Much of it looks the same, but that's because the physics of atmospheric entry haven't changed recently," Griffin said. "We really proved once again how much of it all the Apollo guys got right."

The centerpiece of this system is a new spacecraft designed to carry four astronauts to and from the moon and support up to six crewmembers on future missions to Mars.

"On the inside it will have a totally modernized system," Charles Dingell, JSC Chief Engineer for the Crew Exploration Vehicle (CEV), said. "It's a very flexible spacecraft that will be able to take crews to the lunar vicinity as well as perform crew transfer missions to the International Space Station."

The launch system that will get the crew off the ground builds on powerful, reliable shuttle propulsion elements. Astronauts will launch on a rocket made up of a single shuttle solid rocket booster, with a second stage powered by a shuttle main engine.

A second, heavy-lift system uses a pair of longer solid rocket boosters and five shuttle main engines to put up to 125 metric tons in orbit – about one and a half times the weight of a shuttle orbiter. This versatile system will be used to carry cargo and to put the components needed to go to the moon and Mars into orbit. The heavy-lift rocket can be modified to carry crews as well.

"We estimate that we can use about 85 percent of the facilities that are in play today for the space shuttle [for the CEV]," Griffin said. "The extensive use of shuttle components available today in this architecture is pretty obvious. I would say this approach affords us the opportunity to retain the maximum number of today's workforce for the designs that we have."

Best of all, these launch systems are 10 times safer than the shuttle because of an escape rocket on top of the capsule that can quickly blast the crew away if launch problems develop. There's also little chance of damage from launch vehicle debris, since the capsule sits on top of the rocket.

The CEV is also an improvement over the rudimentary atmospheric reentry of the Apollo era.

"It will have precision-entry targeting, so it can land the crew on land rather than splash down in the ocean," Dingell said.

The new ship can be reused up to 10 times. After the craft parachutes to dry land (with a splashdown as a backup option), NASA can easily recover it, replace the heat shield and launch it again.

Future missions

The journey will start with robotic missions between 2008 and 2011 to study, map and learn about the lunar surface. These early missions will help determine lunar landing sites and whether resources, such as oxygen, hydrogen and metals, are available for use in NASA's long-term lunar exploration objectives.

"This architecture provides global lunar surface access," Griffin said.

This is a great improvement over the Apollo system, since Apollo was limited to studying the equatorial regions of the moon. This new exploration system will also allow us to establish a permanent human presence on the moon while preparing for Mars and beyond.

The first human lunar flight is scheduled for 2018. Coupled with the new lunar lander, this next-generation spacecraft system can send twice as many astronauts to the moon's surface, and they can stay longer, with the initial missions lasting four to seven days.

Once a lunar outpost is established, crews could remain on the lunar surface for up to six months. The spacecraft can also operate without a crew in lunar orbit, eliminating the need for one astronaut to stay behind while others explore the surface.

For larger exploration goals, the CEV could serve as the basic architecture for missions to Mars.

"The CEV is designed with its launch system to go to low Earth orbit. You must go through low Earth orbit to go anywhere else," Griffin said. "We can go to the moon. In later decades, we can go to Mars. We can service the space station. We can undertake the service of the Hubble Space Telescope or other space telescopes, as may exist. We can do anything."