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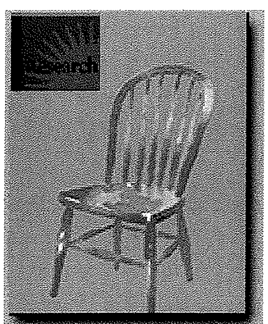

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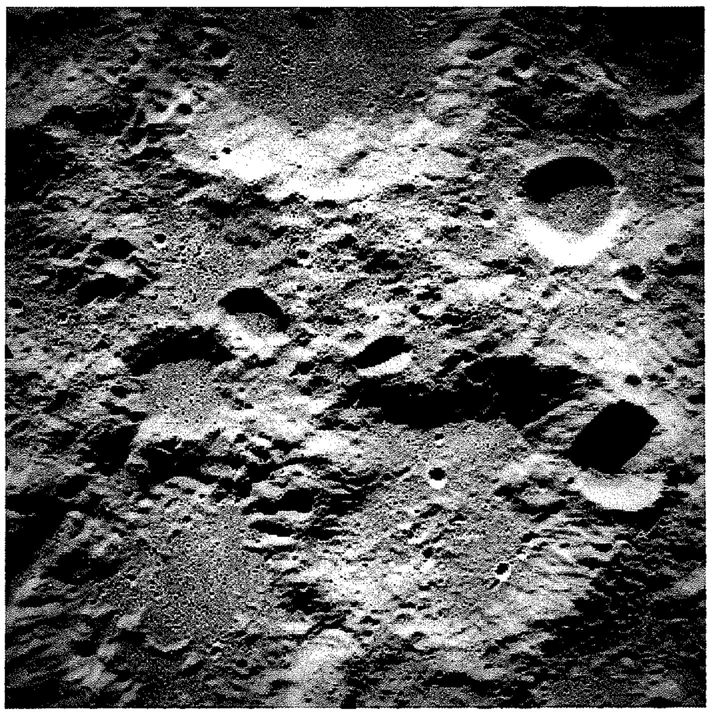
Back to the moon--digitally



by Robert Burnham

For almost 40 years, the complete photographic record from the Apollo moon project sat in a freezer at NASA's Johnson Space Center in Houston. The images were almost untouched, until now.

Scientists at Arizona State University and NASA are working together to create a new digital archive. High-resolution scans of the original Apollo flight films will be available on the Internet. The images are startling. Researchers and members of the general public have access. Go to http://apollo.sese.asu.edu to browse or download the images.

The moon images filmed by astronauts during NASA's Apollo program have never been seen in high-resolution detail by the public. Nor by most lunar scientists.

ASU researchers will use the original Apollo flight films as part of the digital scanning project. Previous scanning projects have been limited in scope. None have used the original films brought back from the moon.

Mark Robinson is lead scientist on the project. The moon has long been the focus of his career. In grade school, Robinson avidly followed the Apollo missions. As a scientist, he worked on Clementine, a 1994 robotic moon mission. Today, Robinson is a professor of geological sciences ASU's School of Earth and Space Exploration (SESE).

Robinson also is the principal investigator for the Lunar Reconnaissance Orbiter Camera (LROC). LROC includes a suite of three separate, high-resolution imagers. It will fly on

(LROC). LROC includes a suite of three separate, high-resolution imagers. It will fly on board NASA's Lunar Reconnaissance Orbiter, scheduled for launch in October 2008.

The scanning project fulfills a long-held wish for the ASU scientist. "It will give everyone a chance to see this unique collection of images with all the clarity they had when taken," he says.

Second-hand moon

Between 1968 and 1972, NASA sent nine manned Apollo missions to the moon. Astronauts snapped about 36,000 photographs in various formats, both from lunar orbit and on the surface. They used standard 35 mm and specially modified aerial-camera frames.

The orbital photographs record lunar surface features as small as 40 inches (1 meter) in size. The photos snapped on the surface were widely published and are familiar to millions of people. They document the astronauts' fieldwork while portraying the stark lunar landscape in all its grandeur.

Until now, this immense image archive from Apollo remained largely unexplored in complete detail. The reason is simple: Apollo photographs are all on film.

Each 35 mm roll, every Hasselblad and mapping camera magazine, contains a unique, first-generation record. All are preserved as they were when they came back from the moon. In fact, several Hasselblad rolls of film taken on the lunar surface show streaks and smudges from moon dust that worked its way into the camera.

Knowing the films were literally irreplaceable, NASA made duplicate sets immediately after the missions. They distributed them to various scientific libraries and research facilities around the world. NASA has given only a handful of researchers access to the original flight films.

As a result, lunar scientists have almost always worked with second- or third-generation copies. And publications aimed at general readers have had to make do with copies still further removed from the source. Multiple copying reduces sharpness and increases contrast. Both effects combine to blur details the original films recorded faithfully.

Out of the cold

Maura White is an image archivist at NASA Johnson. She directs the Apollo scanning project on the Johnson side. She says that preparing each roll of film to be scanned takes a couple of days.

"We bring each film canister out of freezer storage," she explains. "We then leave the canister in a refrigerator for 24 hours." The freezer temperature is set at zero degrees Fahrenheit (minus 18 Celsius), while the fridge holds a steady 55 F (13 C).

"This lets the film warm up slowly," she says. "Then we leave the canister—still sealed—at room temperature for another 24 hours."

Once the film has warmed to room temperature, the canister is opened. The scan crew then inspects the film for damage, cleans it if needed, and places it on the scanner. Once the roll has been scanned, project technicians return it to the canister. Then it's back to the deep freeze, where NASA hopes the film can remain forever. The digital version exists with full fidelity to the original.

"One of the great things about this project," White adds, "is that some of the people who worked here back during Apollo are working with us now. They were involved in handling the films when the astronauts came back from the moon and they are involved in the scanning. It's wonderful having their experience and knowledge on hand."

Sneaker-net

The project will take about three years to complete. Technicians will scan some 36,000 images. These include about 600 frames in 35 mm. There are also almost 20,000 Hasselblad 60 mm frames (color, and black and white), more than 10,000 mapping camera frames, and about 4,600 panoramic camera frames.

To extract all the details from the film, Robinson decided to scan the black and white images at a resolution of 200 pixels per millimeter. That is far beyond what most scanning involves. Color images are at 100 or 120 pixels per millimeter.

“We’re going well past the film grain,” White says.

The scanner was built by Leica Geosystems. Its software was specially modified for the project to increase the brightness range from the normal 12-bit tone depth to 14 bits. This means black and white images record more than 16,000 shades of gray. Color images will use 48-bit pixels to capture the full dynamic range of the film.

Robinson says that combining high resolution and wide brightness range produces very large raw image files. For example, in raw form, the scans of the Apollo mapping (metric) camera frames, each 4.7 inches square, are 1.3 gigabytes in size. Panoramic camera frames, each 5 by 48 inches, are 11.8 gigabytes each.

“Those are much bigger than most people would want to look at with a browser,” Robinson explains. “Even if their browser and Internet connection are up to the job.”

To compensate, the Web site uses a Flash-based application called Zoomify. The program lets users dive deep into a giant image by loading only the portion being examined. Links are available at the site for downloading images in several sizes, right up to the full raw scan.

Getting the images from NASA Johnson to ASU meant a return to an old form of moving files, usually dubbed “sneaker-net.” To avoid clogging the Web servers at Johnson and ASU with enormous files, each week the scan crew loads the images onto 500-gigabyte removable hard drives. The drives are shipped to the Tempe campus.

Once on campus, undergraduate student workers load the image files into the ASU system and do basic processing. They create the smaller-resolution versions and assemble ancillary data on each image.

Nothing happens on the moon?

Robinson has interesting plans for the decades-old images. “We plan to compare them with the images we’ll get from the Lunar Reconnaissance Orbiter,” he says.

Scientists could always visually compare an Apollo-era photographic print with a new digital image from LROC. But having both in digital form speeds up the job and makes it more accurate.

Looking for lunar changes isn’t just academic. Scientists have a good idea of how many tiny meteorites zip through space, thanks to studies made using satellites in Earth orbit.

“We know from the sizes of asteroids how many large impacts are likely,” says Robinson. “But if we’re sending astronauts back to the lunar surface for extended visits, we need data on how often medium-size meteorites strike the moon,” he adds. “Calculations tell us we should see some new lunar craters when we compare LROC’s images with the old ones from Apollo.”

Beyond its utility for lunar exploration, Robinson is delighted the Apollo digitizing project is underway for another reason. “I think these images give everybody a beautiful look at this small, ancient world right next door to us,” he says.

To browse or download the Apollo moon images, go to http://apollo.sese.asu.edu For more information about the scanning project, visit ASU's School of Earth and Space Exploration at http://sese.asu.edu/

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