Assignment: Shoot the Moon – 1967

Narrator: The assignment was specific: get photographs of the surface of the Moon that are good enough to determine whether or not it's safe for a man to land there. But appearances can be deceiving, just as deceiving as trying to get a good picture of, well, a candy apple. Doesn't seem to be too much of a problem, just set it up, light it, and snap the picture. Easy, quick, simple. But it can be tough.

To begin with, the apple is some distance away, so you can't get to it to just set it up, light it, and so on. To make things even more difficult, it isn't even holding still; it's moving around in circles. Now timing is important. You have to take your picture when the apple is nearest to you so you get the most detail and when the light that's available is at the best angle for the photo. And even that's not all. You are moving too, in circles. You're both turning and circling about the apple. Now, about that assignment.

As the technology of man in space was developing, it became more and more apparent that our knowledge of the Moon's surface as a possible landing site was not sufficient. To land man safely on the Moon and get him safely off again, we had to know whether we could set up a precise enough trajectory to reach the Moon. Could we design and build a spacecraft to land gently on the Moon? Among all those lunar craters, could we find a place clear and level enough for a safe landing site?

To make it possible for a man to land in the Apollo zone on the Moon, better pictures were needed than those taken through Earth's best telescopes. In fact, better pictures might do more than find a landing site for Apollo. Scientists hoped they might resolve questions unanswered in the 300 years since Copernicus prompted Galileo to study the Moon. What were the lunar craters Galileo observed? Pits dug by objects hurled from space, or the scars of old volcanoes? Telescopic photographs, far from answering these questions, scarcely reveal features on the Moon as big as the meteor crater in Arizona, almost a mile across and several hundred feet deep.

Well it wasn't easy, but three shots in a row hit specific targets on the Moon, exactly as they were planned to do. And the photographs started coming in. Ranger was designed simply to hit the Moon. Before it crashed into its lunar impact point, it would send back to Earth close-up TV pictures of a portion of the Moon's surface. The first successful Ranger reached a small lunar sea, since renamed Mare Cognitum, "the sea that has become known."

NASA Controller: Mark, it is one minute to impact. All cameras are functioning.

Narrator: As soon as the cameras were turned on, the pictures were transmitted to the tracking station at Goldstone, California. From here they were re-transmitted to the Jet Propulsion Laboratory in nearby Pasadena. Here in the Space Flight Operations Facility, great excitement prevailed as Ranger neared the Moon and its pictures came alive on the TV monitor. At last, scientists could turn to close-up pictures like these.

NASA Controller: Twenty seconds to impact, all video good. Signal normal. Standby for impact. Ten seconds to impact. Video still good. Specs on signal strength. Three, two, one. Impact! Impact has occurred.

Narrator: Prints of each picture were made for immediate study by scientists and engineers. On the theory that all lunar seas were flat and would offer the best landing sites, Ranger examined the surface of two such areas. Surprising to some scientists, the photographs at first showed little evidence of any volcanic activity on the Moon. No boulders, no rubble, no crevasses, no dust. Pictures of craters covering craters suggested that the surface of the Moon was long ago dug into and loosened by repeated impacts.

In Ranger 8 photographs, the first signs of volcanic activity on the Moon seemed to appear. The lunar landscape Ranger's TV cameras explored was bleak, a flat surface studded with craters. Some are miles across; others no bigger than a washtub. All were probably formed billions of years ago.

The last target area was the floor of the Alphonsus Crater, chosen because it was not a lunar sea. There was a lot of interest in the dark smaller craters within Alphonsus, which might explain more about the forming of the lunar surface. On the Alphonsus floor, new signs of variety on the Moon's surface began to appear. Craters caused by volcanoes, long-since dead. But the evidence from these photographs raised more questions than the pictures answered.

It was obvious that some different perspectives were required on the subject. Perhaps a new camera, one that could get very, very close, and another to cover a lot of ground in detail. Surveyor, a far more complex spacecraft, was designed to make a soft landing on the Moon. But once safely down, it would also send back TV pictures of a possible Apollo landing site.

NASA Controller: Lift-off arm switched on…

Narrator: The first Surveyor worked perfectly, made its planned soft landing, and sent back more than 11,000 pictures of a small area in the Ocean of Storms. Surveyor's Moon was dark, relatively smooth, but still studded with craters and littered with rocks. Its pictures made it clear that, where it landed, there is little loose dust on the surface. But neither is the surface hard. It seems to behave much like Earthly soil and will certainly support the weight of a manned landing craft. It supported Surveyor's weight and offered a glimpse beneath the Moon's surface where the shock absorber sank slightly into the material on which it came to rest. After transmitting the first batch of pictures and surviving the dry heat of a lunar noon, Surveyor slept. It slept through the 14 day long lunar night, as temperatures plunged 500 degrees. Then it came awake on command to continue its examination of the Moon.

NASA Controller 1: Minus 125.

NASA Controller 2: Touching…

Narrator: Surveyor took the first color pictures of the Moon, showing a blue-gray surface in contrast to the small color wheel attached to one of Surveyor's feet. In some ways, Surveyor's Moon seemed more hostile than we thought it might be. Some feared that rocks, littering even the smooth plains, might present a landing hazard to any manned spacecraft.

Well, the apple that started all this was still there. Our pictures were beginning to give us some of the answers we needed, but our coverage was spotty. We needed more pictures, more detail, more information. It hadn't been simple to hit the Moon with Ranger, and soft-landing Surveyor had been exceedingly difficult. Lunar Orbiter presented a set of problems different from Ranger or Surveyor. It was designed to circle the Moon with a pair of cameras to photograph large areas of the Apollo landing zone and give good close-up pictures of many possible landing sites. Somebody called it the flying drugstore because it develops its own film. The spacecraft also carries an electronic readout system to scan its photographs and send them back to Earth. Lunar Orbiter was an impressive advance in lunar photography. Here was a first close look at large pieces of the Moon, 16,000 square miles of the Apollo landing zone, with a resolution 100 times better than Earth-based views.

For the manned lunar landing, scientists hoped to find a string a sites in groups of three, each group a series of five-mile-wide ovals strung out in a straight line. Each site would have to be crater-free, have no large boulders, and no surface slope steeper than seven degrees. Of all the areas photographed by the Lunar Orbiters, only a few were expected to prove smooth and level enough to meet all the Apollo landing requirements. The spacecraft photographed several suitable areas. Working with the photographs, scientists observed that the smoothest terrain appears to be the darkest. Using degrees of brightness as a yardstick has made it possible to measure the roughness of the Moon's surface. Really smooth areas are hard to find. Orbiter missions have resulted in the selection of eight possible Apollo landing sites. The most promising seems to be a broad plain on the southeastern part of the Sea of Tranquility, just east of the crater Maskelyne D. Its surface is flat; there are no deep craters, few boulders. The other seven sites stretch along the equator from the Sea of Tranquility to the Ocean of Storms. There was now sufficient data to pinpoint Apollo landing sites for the first mission. In terrain like this, the first lunar landing craft will touch down and man descend to take his first exploratory steps on the Moon.

Orbiter also photographed the far side of the Moon and found it to be even more heavily cratered than the face. These were bonus shots, made because the cameras had to be in continual operation until all the film was exposed. The first high quality pictures taken of this area, they covered 80 percent of the Moon's hidden face.

One of Orbiter 2's bonus pictures was a shot of the crater made by Ranger 8 when it impacted the Moon. The freshness of the crater was determined by measuring the brightness of the volcanic rock around the crater. Originally concentrated and dark in appearance, the material was now powdered and brightened by the force of the Ranger collision.

Lunar Orbiter not only provided outstanding photographs of the Moon, it also helped improve our Earth-bound measurements of the Moon's shape and its gravitational field. Micrometeoroid sensors onboard discovered that a spacecraft orbiting the Moon has no more chance of being hit than one in orbit around Earth. Measuring radiation, Lunar Orbiter 1 experienced two solar flares after completing its photography, flares that would have destroyed its pictures had they occurred earlier. Lunar Orbiter 3 photographed this great 400-mile-long fault, half as deep as the Grand Canyon, and on another part of the Moon, a mountain towering 6500 feet from the floor of the crater.

Other Orbiter photographs reveal many craters filled with what is apparently volcanic debris. Here is a wealth of material for continued study by geologists and other scientists. For example, the crater Copernicus is one of the most prominent features on the Moon. Until not long ago, this photograph, taken through the 120-inch reflecting telescope at the Lick Observatory in California, was the best available. This is Copernicus as seen by Lunar Orbiter 2, 60 miles wide, 2 miles deep, the crater dominates the face of the Moon. Thoth, the keyhole-shaped crater in the foreground, is about 13 miles across and nearly a mile deep. Thoth is 33 miles from Copernicus. Much of this distance is covered with debris blasted from Copernicus by the impact of a giant meteorite billions of years ago.

Rounding the back shoulder of the Moon, one Orbiter got an exceptional shot: the first photograph of Earth seen from outer space. From afar Earth seemed shrouded in clouds, much as Venus has always looked. To scientists, this photograph suggests that Venus may not be hidden beneath a perpetual cloud cover. A TV camera close enough to photograph Venus may find holes through which to see this planet with greater clarity. Who knows what a closer look at the Evening Star will bring, what answers may be found, or what new questions man may have to ask about the nature of the universe.

Other Surveyors have touched down near the Lansberg Crater in the Ocean of Storms and in the Sea of Tranquility, pressing their unmistakable footprints into the lunar surface. Like their predecessor, these Surveyors took a good look at themselves and then turned their television cameras on the lunar countryside. One of the most unusual features of Surveyor 3 was its surface sampler, a five-foot-long arm with a hand-sized scoop. This device was designed to dig into the soil to determine bearing strength and other characteristics. It dug several trenches in the lunar crust. It dumped samples of lunar material on its footpad, allowing close examination of the freshly disturbed soil. In other tests, the scoop was deliberately dropped on the surface and pictures taken of the resulting dents and cracks. Another Surveyor experiment used this alpha scattering device to determine the chemical composition of the lunar soil. At one point, Surveyor's cameras interrupted their look at the Moon to record this event: an eclipse of the Sun by the Earth.

The most important scientific conclusion drawn so far from all these photographs is that the Moon's ancient surface is still slowly undergoing change. This has been caused mainly by the jarring impact of objects hitting the Moon. But whatever the cause, the Moon is not, as we thought, a perfectly preserved relic of the geologic past. Lunar Orbiter has extended the mapping of the Moon to the far side so that features there could be accurately located, and it also survey many important scientific sites. These pictures of the Moon's polar areas disclosed striking new details. This is Orientale Basin, on the extreme western edge of the Moon's disc and stretching 600 miles in diameter. The mountains surrounding the basin are among the most massive on the Moon, rising some 20,000 feet above the surface.

Other areas of interest to scientists have been explored. What are the changing red spots that have been seen in Aristarchus? What makes the crater's wall so bright? What kind of erosion created the river-like channel in the Alpine Valley? Was it volcanic, or was it, as some conjecture, the result of water on the Moon's surface eons ago? What is the explanation of Cobra Head? How was it formed? Why are there certain color differences in this region? Near the Harbinger Mountains lie a number of curious craters with sinuous channels extending from them. Scientists will try to deduce what could have happened on the Moon's surface to account for them.

Because of the astonishing detail of pictures like these, the yield of information is great. For example, this rock is 75 feet across. From the picture it is possible to tell that it rolled downhill some 900 feet, scraping away the lunar topsoil. This rock is only 15 feet across, but it too left a trail that can be clearly seen. Oblique photos of the Copernicus Crater would seem to exclude it as a suitable landing site for a manned spacecraft. But a look at other Copernicus photos taken from a nearly vertical perspective reveal several promising possibilities, particularly here in the northwest area. And surprisingly enough, these lunar photo missions have shown scientists views of Earth no man had ever seen before. This is the first photograph of the nearly full planet from 215,000 miles away. It will provide additional information on the amount of sunlight reflected by Earth.

Lunar Orbiter has successfully surveyed 99 percent of the Moon's front face and significantly increased high resolution coverage of the far side. These pictures are likely to be the source of lunar surface information for many years and should contribute to a fuller understanding of the Moon. If many other questions are still in doubt, some of the answers may already be in our hands. Examination of these photographs is not complete and already they've produced miles of data tapes to be processed. And additional information is being returned so rapidly, that it will take years to evaluate it all.

In 1950 astronomer Fred Hoyle lamented that man had seen all he would ever see through even the most powerful telescopes. It was time, he said, to leave the Earth. Within a hundred years from 1950, Hoyle hoped man might be able to launch a rocket with a radio-operated camera and see the Earth as it looks from outer space. Much more has been done. The doing wasn't easy; the plans didn't always work. But when they did, they took us beyond the dreams of the fifties to a point where, within 20 years of Hoyle's modest wish, two Americans will actually land on the surface of the Moon. In the meantime, there will be more great pictures like this now-famous photograph. When this happens Hoyle predicted, when we can leave Earth with a camera, move out into space, it is certain to make marked changes in our whole outlook on life. The apple is still there.