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Shooting for the Moon

by Andrew J. LePage
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Introduction

As the first full calendar year of the Space Age was winding down, American and Soviet teams were pushing hard to be the first to reach the Moon. Between August and early December of 1958, the two countries had each made three attempts to launch lunar probes (see **The First Race to the Moon** in the August 1998 issue of *SpaceViews*). The three Soviet attempts were unsuccessful due to problems with their newly developed Moon rocket, the 8K72. The first three American probes, originally part of a USAF effort to send spacecraft into lunar orbit that was transferred to NASA, at best only made it into ballistic trajectories that brought them no where near their target. While these three USAF-sponsored lunar probes were unsuccessful, NASA hoped that the last pair of Pioneer probes developed by teams at JPL (Jet Propulsion Laboratory) under William Pickering and ABMA (Army Ballistic Missile Agency) under Wernher von Braun would fare much better.

Pioneer 3

The Pioneer lunar probes designed by JPL were much more modest than those built by either STL (Space Technology Laboratory) for the USAF or the Soviet Union's E-1 probe. These tiny, conical probes weighed just six kilograms (13 pounds) each and were instrumented to survey the radiation environment in cis-lunar space. The diminutive size of these probes were the direct result of the limited payload capability of their launch vehicle. Developed by von Braun's team at ABMA, the Juno II was cobbled together from modified components of the Jupiter IRBM and the high-speed solid rocket assembly used by the Juno I that launched America's first satellite (see **Explorer: America's First Satellite** in the February 1998 issue of *SpaceViews*). The design was hardly optimum for the task but it could still just barely send a usable payload to the Moon. Given the desperation in the United States at the time, almost anything would be attempted to beat the Soviets to any significant goal in space.

The tiny Pioneer 3 and 4 probes developed at JPL for the ABMA lunar missions. (JPL/NASA)

The first of the JPL/ABMA lunar probes, Pioneer 3, lifted off from Pad 5 at the Atlantic Missile Range at 12:45 AM on December 6, 1958 - the first anniversary of the disastrous Vanguard TV-3 failure. While at first the launch looked good, a review of the telemetry showed that the Jupiter AM-11 booster had

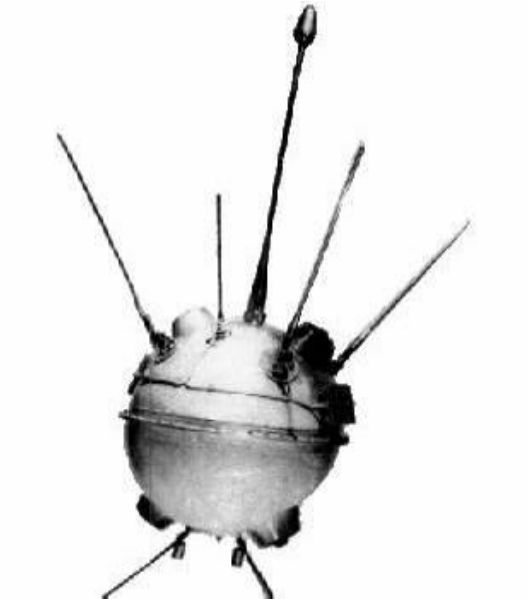
cut-off 3.7 seconds early and that the trajectory was lower than planned. Like its predecessors, Pioneer 3 failed to escape the Earth. Early telemetry from Pioneer 3 also indicated that its despin mechanism failed to operate as intended leaving the probe spinning at the launch rate of 415 rpm instead of the slower 11 rpm required for the mission.

Pioneer 3 reached a peak altitude of only 102,300 kilometers (63,580 miles) before it burned up over what was then French Equatorial Africa 38 hours and six minutes after launch. Despite the failure, Pioneer 3 still made useful measurements that confirmed the extent of Earth's Van Allen radiation belt and discovered a second belt between 16,000 and 64,000 kilometers (10,000 and 40,000 miles) above the Earth. While scientifically important, it still did not make up for the fact that yet another American spacecraft failed to reach the Moon.

The "Dream" Probe

Despite the growing pains experienced during the first 8K72 launches and lagging development of its larger sister Moon rocket, the 8K73, Korolev's team of engineers were quickly climbing the learning curve enabling them to build more reliable and higher performance machines based on the adaptable R-7 ICBM. One such change was to load the Blok E third stage of the 8K72 with a denser grade of kerosene than that used by the core and strap-on boosters thus increasing the stage's fuel load. These and other refinements now allowed the 8K72 to loft over 360 kilograms (790 pounds) into a direct ascent, 34-hour long trajectory towards a lunar impact. Over the coming months these enhancements would doom the increasingly redundant and troubled 8K73 development program.

Originally limited to an estimated mass of 170 kilograms (375 pounds), the E-1 probe nicknamed "Lunik" by its builders (a moniker that was later applied by the West to all early Soviet lunar probes) could now afford to gain some weight. The E-1 was a 1.2 meter (4 foot) in diameter, polished aluminum-alloy sphere with a pressurized interior designed to maintain a temperature of 20 C (68 F). It contained all the sensitive electronic equipment including the transmitter, instruments, and batteries to power it all for about 60 hours. Its impressive suite of scientific instruments included a magnetometer mounted on a one-meter long boom, a piezoelectric micrometeorite detector, and devices to detect and characterize various types of cosmic radiation. The fattened E-1 No. 4 weighed in at about 192 kilograms (423 pounds).



The Soviet's first E-1 lunar probe, called Mechta (later designated Luna 1), to escape the Earth. (Author's collection)

Instead of wasting the unused payload capability of the 8K72, it was decided that the Blok E escape stage would carry another 169 kilograms (372 pounds) of scientific and radio-equipment to supplement Lunik's measurements. Included was a package to vaporize 1 kilogram (2.2 pounds) of sodium to produce a short-lived artificial comet on the way to the Moon. Originally suggested by Soviet astronomer Iosef Shklovsky, this experiment would yield interesting insights into Earth's outer magnetosphere and serve as a tracking aid.

As the world rang in 1959, 8K72 serial number B1-5 was rolled out onto its pad at the NIIP-5 test range in snow covered steppes of Kazhakastan. Under the rocket's nose was 361.3 kilograms (795.6 pounds) of payload including the E-1 No. 4 Lunik probe. At 8:00 PM Moscow Time on January 2, 1959 the giant Moon rocket lifted off in the Soviets' fourth attempt to reach the Moon. Unlike the previous flights, this time the first two stages did not suffer any major malfunctions allowing the Blok E stage to push its cargo towards the Moon.

Initial tracking of the probe and escape stage indicated that everything worked and that escape velocity had been achieved for the first time. Lunik, now officially named "Mechta" (Russian for "Dream" but later in history retroactively designated "Luna 1"), was on its way to the Moon. Eight hours after launch at an altitude of about 120,000 kilometers (75,000 miles) over the Indian Ocean, the spent Blok

E released a fluorescent cloud of sodium vapor that expanded to 650 kilometers (400 miles) across in five minutes before disappearing from sight. Visible from most of the Eastern Hemisphere, this spectacle was proof that the Soviets were on the way to the Moon.

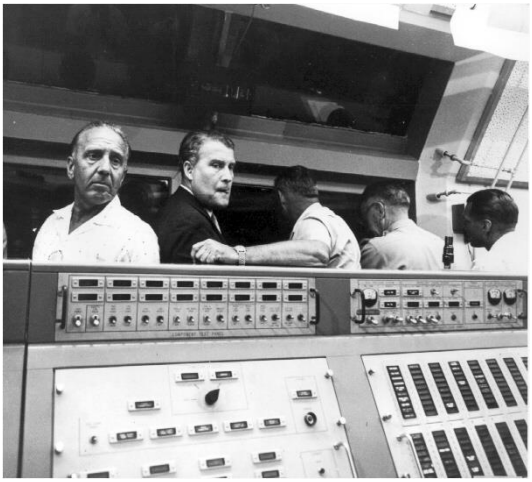
Despite the initial flurry of excitement, careful tracking indicated that the escape stage had imparted slightly too much speed causing the probe to miss the Moon. On January 4, 34 hours after launch, Lunik passed within 6,000 kilometers (3,700 miles) of the Moon on its way into solar orbit. Even though it failed to hit the Moon, the probe's instruments worked perfectly and returned useful data on the cis-lunar environment for the first time. The Soviet press, however, trumpeted the flight as a total success with the first close pass by the Moon and the first man made planet in orbit of the Sun.

Mechta was tracked until 62 hours after its launch on January 5, 1959. At a range of about 500,000 kilometers (300,000 miles), the probe's batteries finally gave out ending a less than successful but fruitful mission. The partial success of Mechta's mission provided enough fuel for the Soviet propaganda machine to allow Korolev the time he needed to analyze the mission's results and plan the next step. In the mean time, another apparent space first for the Soviet Union along with the immense size of the payload weighed heavily on an increasingly nervous West.

America's Reply

The success of the Soviet Lunik probe had an incredible impact on NASA. Under increasing pressure, von Braun needed to make his second - and last - shot at the Moon a success. Except for some additional lead shielding on one of the Geiger-Muller tubes, the 6.1 kilogram (13.4 pound) Pioneer 4 was identical to its unsuccessful predecessor. The tiny probe was finally sent on its way by Juno II Round AM-14 at 1:45 AM on March 3, 1959.

A slightly longer than planned burn of the second stage along with a nearly nominal performance of the other stages guaranteed this time that Pioneer 4 had surpassed escape velocity. But calculations based on early tracking of the receding probe quickly showed that this excess velocity and the inevitable aiming errors conspired to place Pioneer 4 on a trajectory that would not pass within 32,000 kilometers (20,000 miles) of the Moon as planned. Instead it would pass the Moon at a distance of 60,000 kilometers (37,300 miles) or around 35 lunar radii - a wide miss by any measure.



Von Braun and other ABMA leaders in the blockhouse during the launch of Pioneer 4. (MSCF/NASA)

Two days after launch, Pioneer 4 passed the orbit of the Moon and continued to relay its measurements back to the 85-foot (26-meter) tracking antenna at JPL's Goldstone Station. After 82 hours of operation, the probe's batteries were finally exhausted as Pioneer 4 passed a range of 655,000 kilometers (407,000 miles) on its way into solar orbit. Engineers were confident that they could have tracked Pioneer 4 out to a range of 1.1 million kilometers (700,000 miles) if the batteries had not given out. But despite the new data returned by the probe and the setting of a long distance communications record, the American public still worried about the Soviet Union's growing lead in space and America's feeble attempts to catch up.

Impact at Last

Even though the flight of Mechta had generated a lot of propaganda, the goal of actually hitting the Moon was still unachieved. After a six month hiatus, Korolev and his team were ready to try again. The next probe would be a modified version of the original designated E-1A. Based on experience with Lunik, improvements were made to the instruments and the antenna housing. The first of these improved probes, E-1A No. 5, was set to be launched on 8K72 serial number I1-7 on July 16, 1959.

Because the fuel tanks of the Blok E escape stage were mistakenly filled with a lighter grade of kerosene, launch was postponed while the tanks were emptied and flushed. Two days later the first of the modified Lunik probes was on its way. But unlike the previous launch, this ascent would not pass without incident. About 153 seconds into the

mission, the gyrohorizon in the rocket's guidance system failed. Unable to sense its attitude, the uncontrolled rocket and its payload were destroyed by range safety.

After a short review to determine the cause of the failure and correct it, 8K72 serial number I1-7A was rolled out onto the pad for an attempt to launch the 390.2 kilogram (859.2 pound) E-1A No. 6 payload on September 9, 1959. This attempt was timed to take place just before Khrushchev's tour of the United States which was set to start on September 15. A successful mission would give the Soviet Premier a valuable propaganda tool. But the first attempt was aborted a half a second before lift off when the core's engine failed to attain full thrust. The rocket was removed from the pad and its payload was quickly transferred to a backup launch vehicle. On September 12, 8K72 serial number I1-7B successfully lifted off and finally sent a second Soviet probe towards the Moon.

Radio tracking and sightings of the sodium vapor cloud released by the escape stage six hours after launch at a distance of 156,000 kilometers (97,000 miles) confirmed that the "Second Cosmic Rocket" had not only escaped the Earth but was on course for a lunar impact. At 12:02:24 AM Moscow Time on September 14, 1959 what would one day become known as Luna 2 impacted the Moon at about 30 north latitude on the lunar prime meridian near the crater Archimedes at a speed of 3.3 kilometers (2.1 miles) per second. While observations by Eastern Bloc astronomers of a dust cloud kicked up by the impact were unconfirmed by the West, the radio dish at Jodrell Bank tracked the Soviet lunar probe as it accelerated towards the surface independently confirming Korolev's feat. The Soviet Union had another space first.

The importance of this near bulls eye shot was not lost on leaders in the West. Not only were the Soviets the first to actually hit the Moon, they had the technology needed to hit any target near (and presumably on) the Earth. But with this new milestone attained, Korolev quickly turned to beat the Americans again to the next goal: Securing the first images of the unseen farside of the Moon.

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Author

Drew LePage is a physicist and freelance writer specializing in astronomy and the history of spaceflight. He can be reached at lepage@visidyne.com.