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Los Alamos – A Short History

At 5:45 am on the morning of July 16, 1945, the world's first atomic bomb exploded over a remote section of the southern New Mexican desert known as the Jornada del Muerto, the Journey of Death. Three weeks later, the atomic bombs known as Little Boy and Fat Man brought World War II to an end. Working literally around the clock, these first atomic bombs were designed and built in just thirty months by scientists working at a secret scientific laboratory in the mountains of New Mexico known by its codename, Project Y, better known to the world as Los Alamos.

Los Alamos

Los Alamos sits 7500 feet above sea level on the rugged Pajarito Plateau of Northern New Mexico's Jemez Mountains. Ancestral Pueblo Indians, the original occupants of the plateau, abandoned the region in the mid-1500s because of a series of droughts. At the turn of the twentieth century Hispanic homesteaders grazed livestock on the plateau and loggers harvested the massive Ponderosa Pines growing in the surrounding area. Shortly before World War I, Detroit native Ashley Pond established the Pajarito Club, an exclusive hunting and fishing camp, in one of the many canyons surrounding the plateau. When the Club's trout stream disappeared underground, Pond closed the Pajarito Club and started The Los Alamos Ranch School, a private school for boys that combined the teaching of classics with the rigors of outdoor life. When student enrollments declined with the onset of World War II, the school was sold to the War Department for a secret war-related project. This secret project, the development of the atomic bomb, brought the most modern form of science and technology to the western frontier of New Mexico.

Fission and the Founding of the Los Alamos Laboratory

Fission, the splitting of an atom of uranium, was discovered in 1939 by two German scientists, Otto Hahn and Fritz Strassman. Their discovery made atomic bombs theoretically possible, but only if many millions of atoms could be split in an uncontrolled fission chain reaction lasting just a few fractions of a second. In December 1942, Nobel Laureate Enrico Fermi conducted his famous experiment at the University of Chicago proving that a fission chain reaction could be initiated. Converting Fermi's successful experiment into a combat weapon required The Manhattan Engineer District (MED), so named because its first offices were in Manhattan, to build and staff three major scientific and technical laboratories. Two of these new laboratories, Oak Ridge and Hanford, supplied the nuclear materials for atomic bombs, uranium and plutonium respectively. Plutonium, an entirely man-made element discovered in 1941, held promise of being a better nuclear bomb material than uranium. The third laboratory, Los Alamos, was given the mission of designing, engineering, and building the first atomic bombs - Little Boy and Fat Man.

Access to unlimited power and water sources dictated the locations for both Oak Ridge and Hanford. Security dictated the location for Los Alamos. Among the security considerations were isolation from major population centers and a climate conducive to outdoor work that could be conducted in secrecy. Jemez Springs, a small New Mexico mountain community was initially selected, but was opposed by the man selected by Brigadier General Groves, Jr. to build the first atomic bombs, J. Robert Oppenheimer. Oppenheimer, who knew Northern New Mexico first hand, suggested Los Alamos. Groves concurred and the War Department purchased the Los Alamos Ranch School. The MED also took title to the surrounding forty-three square miles of land. Ranch School buildings were used for housing senior staff, as a small hotel, and as dining hall. Many of these buildings still exist today.

Like Oak Ridge and Hanford, Los Alamos was built from the ground up – and very quickly. Working under Groves' authority, The Army Corps of Engineers' Albuquerque Office hired contractors willing to work without blueprints, detailed plans, or a firm contract. Construction included technical buildings as well as housing for a quickly growing scientific staff. While this construction met the very urgent wartime goals, it was never adequate. The first classified technical conference for all senior scientists, held in April 1943, was interrupted when a construction worker nearly fell through the ceiling of the room where the meeting was being held. Housing, universally detested, was tolerated, but only as a patriotic wartime sacrifice. Emilio Segre, one of many European scientists working at Los Alamos, and later a Nobel Laureate, complained to housing officials about the overheating of his apartment, saying on more than one occasion that "the temperature of the walls in the apartment reached such a point that there was obviously immediate danger of a fire." On one such occasion, fearing a fire, Segre had to run to the nearest telephone, located at a distant security station, to place an emergency call for assistance. The phone didn't work. As Segre went on to say, "The repetition of such occurrences and the precarious state of the alarm system on the Post makes me exceedingly uncomfortable, especially because having two small children at home. I don't feel safe leaving them alone even for a very short time." The response was a desultory "It is entirely possible that the telephone was out of order at the time you tried to call." Laboratory buildings were somewhat better constructed, but only because the heavy machinery they housed required stouter construction. Office space was limited and spartan. Shortly after moving into his Los Alamos office, Oppenheimer had to request a nail to hang his coat and hat on. By the end of the war, most laboratory and housing structures were literally falling apart.

The Technical Program

To manage Los Alamos, Groves hired J. Robert Oppenheimer, a University of California physicist. Although one of the nation's premier theoretical physicists, Oppenheimer was not Groves' first choice to lead Los Alamos. Oppenheimer, a true academic, lacked both management and leadership experience. He also had a questionable background. His wife, Kitty, was the widow of a communist. And, as some intelligence operatives knew, Oppenheimer had been asked by a casual acquaintance to provide technical information to the Union of Soviet Socialist Republics (USSR). Nonetheless, Groves hired Oppenheimer because he was the best scientist available. Oppenheimer quickly recruited a staff of preeminent scientists, including Hans Bethe, Edward Teller, and Edwin McMillan, along with many of their graduate students.

The choice of Oppenheimer proved providential to the success of the Laboratory. Hans Bethe, for one, believed that Los Alamos achieved its outstanding wartime success only because of Oppenheimer and his singular ability to meld the wartime goal Laboratory with exceptional staff.

During the April 1943 conference, the one interrupted by a leg dangling from the ceiling, those gathered quickly agreed on a primary method achieving fission in an atomic bomb. This method, gun assembly, would shoot one piece of subcritical nuclear material, either uranium or plutonium, at a second subcritical piece of the same material. Once mated the two pieces would become supercritical and yield a nuclear explosion. This "gun method" of assembly ultimately became Little Boy.

A second possible method of assembly, implosion, also was discussed at the April 1943 meeting. Implosion is the compression of a ball of nuclear material into a supercritical mass that too would yield a nuclear explosion. The implosion assembly method became *Fat Man.* However, implosion was more theory then reality and was not pursued with much vigor during the first year of Laboratory's operations.

Gun technology, both ancient and well known, seemingly provided the surest path to an atomic bomb using either Uranium or Plutonium. Groves agreed and hired the preeminent gun engineer in the United States military, Navy Captain William S. (Deke) Parsons, to head the Laboratory's gun assembly research and development. Despite the Laboratory emphasis on gun assembly, some staff members pursued implosion research in a clandestine fashion. While Parsons was away from Los Alamos on July 4, 1943, some of his staff conducted a surreptitious proof of principal implosion experiment. The experiment was successful and, fortunately, kept implosion from being totally neglected.

In the spring of 1944, an experiment conducted by a small group of graduate students near the location of Ashley Pond's long-abandoned Pajarito Club, discovered an isotopic impurity in Plutonium, one that could not be removed. If Plutonium was used in a gun assembled weapon, this impurity would cause a premature explosion, known as spontaneous fission. Without an alternative assembly method, Plutonium could not be used at all for an atomic bomb. While gun assembly was still possible using Uranium an ongoing production shortage of this material made its use questionable. Los Alamos and the nation faced the real possibility that an atomic bomb could not developed. Needing to use Plutonium, Oppenheimer decided to develop implosion. Subsequently, he reorganized Los Alamos in August 1944, shifting the focus away from work on gun assembly to developing the implosion. Oppenheimer also created a special group known as the Cowpuncher Committee to "ride herd on implosion" and guarantee its success. Gun assembly, still viable for uranium, required a less intensive effort to perfect.

Trinity: The First Nuclear Test

The implosion system developed at Los Alamos proposed using the supersonic shock waves produced by almost three tons of high explosives to symmetrically crush a small ball of Plutonium into a supercritical mass. The complexity of this process, never before attempted on a large scale, required a proof of principle test before a combat weapon could be engineered and used. This test, codenamed Trinity, was planned for the summer of 1945.

Eight potential test sites for Trinity were identified and evaluated by Oppenheimer. Four of these sites were in New Mexico, two in California, and one each in Colorado and Texas. As described by Test Director, Harvard University Professor Kenneth Bainbridge, "Scientific considerations required the site to be flat to minimize extraneous effects on blast. The large amount of optical information desired required that, on average, the weather should be good, with small and infrequent amounts of haze or dust and relatively light winds. Ranches and settlements should be distant to avoid possible danger from the products of the fission bomb. Another major consideration was the requirement of minimum loss of time in travel by personnel and transportation of equipment between Project Y and the site." The Jornada del Muerto, located about 200 miles south of Los Alamos, best met these criteria. The area, part of the Army Air Corps' Alamogordo Bombing Range, was reserved by the Manhattan Project for Trinity. So that the test could be directly observed, photographed, and instrumented, the Trinity device was placed atop a 200 foot tall Forest Service tower. Photographic and instrumentation stations were constructed in wide circle around the tower to record and document the explosion. By early July, the Trinity device was ready.

Trinity's high explosives sphere, consisting of individual charges known as lens (because each charge was designed to focus the shock wave in the same manner as the lenses of eye glasses), were assembled in a remote section of Los Alamos. Placed on a truck, this high explosive sphere, five feet in diameter, was driven to Trinity Site, passing through the middle of Albuquerque during the middle of the night. The plutonium subassembly was placed in the trunk of a Plymouth sedan and driven to the site. A moment of high drama occurred at ground zero when the plutonium subassembly was being inserted in the high explosive ball – it didn't fit, despite all of the care taken in designing and building the parts. Those around the device were stunned. All activity came to a halt. Fortunately the man responsible for building Fat Man, Robert Bacher, had the presence of mind to understand that the Plutonium had been in the trunk of a car sitting in the hot desert sun. The Plutonium had expanded in the heat just enough to cause problems. Once its temperature equalized with that of the high explosive sphere, it slipped into place. After the device was completely assembled, it was hoisted to the top of the tower and readied for its debut. Fearing that the five ton device might fall during its ascent up the tower, mattresses were placed at the bottom of the tower to cushion any fall.

Throughout the night of July 15, 1945, and into the early morning hours of July 16th, J. Robert Oppenheimer, stood in the darkness of the Jornada del Muerto nervously waiting for the detonation of the world's first atomic bomb. For Oppenheimer, the waiting was a culmination of the stress he had been facing since he first organized Los Alamos in April 1943. Living on coffee and cigarettes, and never weighing more than 130 pounds, his weight had dropped to below 100 pound from the stress of organizing the Laboratory and guiding its scientific and technical operations. Groves had become so concerned about Oppenheimer's health that brought Frank Oppenheimer to Los Alamos to provide support for his brother.

In the last few hours of early morning darkness the question that ran through Oppenheimer's mind, and that of the hundreds of other scientists, was would Trinity work. Oppenheimer's concern about the test was justified. While high explosives in the form of small shaped charges had been used before, most notably in the sculpting of Mount Rushmore, their use as the trigger for an atomic bomb was novel and worrisome. Seeking to lighten the anxiety of Oppenheimer and others, Norris Bradbury penned a humorous entry in the test time table:

"Sunday, 15 July, all day. Look for rabbit's feet and four leafed clovers. Should we have the chaplain down there?"

At 5:45 a.m. Mountain War Time, just moments before the first rays of daylight appeared, *Trinity* exploded with the force of approximately 20 kilotons, lighting up the southern New Mexico sky. The early morning time was selected so that the initial explosion would occur in darkness making the fireball visible against the dark sky, but with daylight quickly coming so that the radioactive cloud could be tracked visually. Although the test was a secret, even from many at Los Alamos, a few people managed to standing on mountain tops looking south as the light from Trinity illuminated the horizon.

Reactions to *Trinity* varied among the scientists who witnessed the detonation. Oppenheimer recalled a line from the Sanskrit poem, the **Bhagavad Vita**, "I am become death, the destroyer of worlds." Bainbridge said simply, "Now we are all sons of bitches." Nobel laureate, Enrico Fermi, took out a piece of paper and tore it into small pieces. As the blast wave passed by him, Fermi dropped the pieces of paper as an experiment to calculate the yield of the blast. As Fermi later wrote, "About 40 seconds after the explosion, the air blast reached me. I tried to estimate its strength by dropping from about six feet small pieces of paper before, during and after the passage of the blast wave. Since, at the time, there was no wind I could observe very distinctly and actually measure the displacement of the pieces of paper that were in the process of falling while the blast was passing. The shift was about 2½ meters, which, at the time, I estimated to correspond to the blast that would be produced by ten thousand tons of T.N.T." Fermi's calculation underestimated the force of the blast by ten kilotons. Edward Teller prepared for the anticipated intensity of the blast's heat and light by liberally applying sun tan lotion. Richard Feynman, a future Nobel laureate, took off his protective goggles to witness the blast with his unshielded eyes only to be temporarily blinded by the explosion's fireball. Harvard chemist and Russian émigré, George Kistiakowsky, wrote, "The flash lit the countryside like a hundred suns and the reflection from the far away mountains near blinded me for a few seconds." Physicist I.I. Rabi, like Fermi a Nobel Laureate, won the betting pool on the size of Trinity's yield. His choice, 18 kilotons, was not based on scientific reasoning. Rabi, traveling from the East Coast, had arrived late at Trinity Site and bought the last remaining number in the betting pool. Anticipating that the explosion would be heard and perhaps seen at great distances, and seeking to protect nuclear secrecy, Groves hired New York Times Reporter William Laurence to prepare a press release announcing that an ammunition dump had accidentally exploded. The press release, written weeks before Trinity, said, in part, "Several inquiries have been received concerning a heavy explosion which occurred on the Alamogordo Air Base reservation this morning. A remotely located ammunition magazine containing a considerable amount of high explosives and pyrotechnics exploded. There was no loss of life or injury to anyone, and the property damage outside the explosives magazine itself was negligible."

Trinity worked, and worked well, validating implosion assembly. By extension, Trinity also proved that fission could be engineered into an atomic weapon. Little Boy would not have to be tested. The bombings Hiroshima and Nagasaki soon followed. As Richard Rhodes has written, "the atomic bombs didn't win the war, but they certainly ended it."

Post War Los Alamos and Testing

Beyond its immediate implications for the ending of the war, Trinity had two other significant implications. First and foremost, Trinity opened the nuclear era and the continued development of atomic bombs. This meant, of course that nuclear tests would be conducted in the future. Second, Trinity pointed out the need for a new test site. The Jornada del Muerto was not sufficient in size to accommodate follow-on tests. Although the Jornada del Muerto was large enough to contain a twenty kiloton explosion, it was too small to accommodate larger yield devices. The Jornada del Muerto also was too small to contain the radioactive fallout that is a byproduct of all atmospheric nuclear tests. Anticipating local fallout from Trinity, monitoring stations were placed in the surrounding towns and villages. However, since none of these communities received fallout, Oppenheimer and others believed Trinity's fallout was localized near ground zero. Initial surveys seemingly bore out this belief, with only a few hotspots detected along with beta burns to a small herd of cattle. But news from distant Schenectady, New York, the home of the Kodak Corporation, came as a surprise. Defective Kodak film was being returned in unusually large amounts. A Kodak scientist traced the problem to shipping containers made from wheat straw harvested from grain fields in Indiana. This same scientist identified the likely source – an atomic event, or detonation. Unwittingly, he became the first scientist to analyze an atomic detonation by forensic examination of radioactive debris - a harbinger of things to come. While Los Alamos scientists knew that radioactive debris entrained in wind currents would be disbursed; they had no real data about how far that distance could be. It was a surprise that fallout was carried to distant Indiana, and an even bigger surprise that, despite secrecy, the source of the fallout could be so easily determined. Future nuclear tests would have to be conducted elsewhere, preferably beyond the boundaries of the continental United States.

Los Alamos, Post War Nuclear Testing, and the Nevada Test Site

Immediately after the end of World War II, political and military leaders argued for one or more nuclear tests to show the world the destructive power of this new bomb. One proposal called for testing the effects of the atomic bomb against a fleet of ships. Out of this lobbying came Operation Crossroads, planned and executed by the Navy at Bikini Atoll in the Marshall Islands. Bikini was selected in large part because of its remote location in the Pacific Ocean. Not only would radioactive fallout from any nuclear test disappear in the vast expanse of the Pacific Ocean, more importantly the continental United States would not be exposed to either blast or radiation effects. Crossroads was carried out successfully in the summer of 1946. Bikini was abandoned and largely forgotten after Crossroads. The Bikini Islanders removed from their ancestral homeland prior to Crossroads, also were forgotten, living in exile. Operation Sandstone followed in 1948. Conducted at Enewetak Atoll, also in the Marshall Islands, Sandstone also involved the relocation of a native population from its ancestral home. Operation Greenhouse, also conducted at Enewetak, followed in 1951.

Although Bikini and Enewetak were adequate for the first these three test series, the atolls were far from ideal as test sites. The amount of real estate was limited, particularly as individual tests grew in yield. Conducting tests at these remote locations also was very restrictive and expensive. Weather conditions, primarily wind directions, limited testing to six months out of every year. The logistics of site preparation and the movement of men and material had to be done by large military task forces, an issue that became acute when the military requirements of the Korean War threatened the execution of Greenhouse. Given these limitations, Los Alamos was constrained in the number and character of each test it carried out. Often, a test was conducted only because it met multiple technical requirements. Rapid advances in weapon design also made the Pacific Proving Ground a less than ideal test site. These rapid advances required more frequent and cheaper testing grew. Los Alamos, which had the mission of “maximizing the nation’s strength in the applications of nuclear explosives for military purposes,” sought to replace “a large fraction of the computation and model experimentation with frequent real tests of the efficacy of new models.” By doing so, the Laboratory could maintain the “significant overall superiority of the United States in its ability to wage atomic explosive warfare through research and development, by the most effective usage of current production of fissionable and other pertinent materials.”

The creation of the Nevada Test Site was critical to the success of this work of Los Alamos, which included the development of the first hydrogen bomb in 1952. In just a few short months after the selection of the Nevada site, Los Alamos conducted the first, Ranger-Able, on January 27, 1951. For a time, both the Pacific and Nevada sites were used simultaneously. Bikini and Enewetak continued in use for very high yield detonations and Nevada for tests less than forty kilotons. Bikini and Enewetak were abandoned when the test moratorium took effect in 1958. When nuclear testing resumed in 1961, Los Alamos relied on the Nevada Test site to fulfill its national security mission. On September 23, 1992, Los Alamos executed, Julin-Divider at the Nevada Test Site, the final United States nuclear test – perhaps ever.