The Manhattan Project:
The Turning Point of Thin Man

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Historical Paper

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I chose the Manhattan Project as my topic because I live in Los Alamos, and I want to honor my town's history. My topic relates to the National History Day theme, *Turning Points in History*, because when the Manhattan Project scientists switched from building the plutonium-239 gun-type Thin Man bomb to designing the plutonium-239 implosion-type Fat Man bomb, it was a turning point in history. When scientists discovered that the Thin Man bomb design would not work, Oppenheimer reorganized the Los Alamos Lab to work on the Fat Man bomb instead. I conducted my research by going to the Bradbury Science Museum in Los Alamos, interviewing Los Alamos National Laboratory historian Alan Carr, and searching the internet. I created my project by writing a research paper.

My historical argument is that switching from the Thin Man bomb design to the Fat Man bomb design during the Manhattan Project was an important turning point in history. This topic is significant because using the two nuclear bombs, the plutonium-239 implosion-type Fat Man and the uranium-235 gun-type Little Boy, against Japan led to the end of World War II. It is possible that Germany might have been bombed with Fat Man in early 1945 if the scientists had researched an implosion bomb design starting at the beginning of the Manhattan Project because the Fat Man bomb and the plutonium-239 might have been ready in early 1945 before Germany surrendered. This would have been a significant change in history.

Getting the Fat Man bomb design to work allowed the U.S. to drop two atomic bombs on Japan within three days. If the Fat Man design had not worked, the U.S. could only have dropped Little Boy on Japan in August 1945. This is because most of the uranium-235 that had ever been separated was used in Little Boy. The Fat Man bomb could be produced much more quickly since it needed less material than the Little Boy bomb and eventually the plutonium-239 was

faster to produce. If the U.S. only dropped one atomic bomb on Japan, then Japan might not have surrendered unconditionally or as soon as they did.

Research Paper

The theme of National History Day in 2024 is Turning Points in History. I chose to study the Manhattan Project because I grew up in Los Alamos, the town where part of the Manhattan Project happened. The Manhattan Project was the codename for the overall atomic weapon project in the U.S.[1] During the Manhattan Project, scientists created the first atomic bombs to use during World War II (WWII).[2] The scientists designed two gun-type bombs at first, Little Boy that used uranium-235 and Thin Man that used plutonium-239.[3] During the Manhattan Project, the Los Alamos Lab director, J. Robert Oppenheimer, had to stop research on Thin Man due to problems with the design and reorganize the Los Alamos Laboratory to make a new bomb design[4]. Fat Man was the implosion-type plutonium-239 bomb that the scientists created later.[5]

Oppenheimer's decision to build the Fat Man implosion-type plutonium-239 bomb after finding that the Thin Man gun-type plutonium-239 atomic bomb would not work was a turning point in history. Successful detonations of Little Boy on Hiroshima, Japan on August 6, 1945 and of Fat Man on Nagasaki, Japan on August 9, 1945 ultimately led to the end of WWII.[6]

In August 1939, nuclear physicist Leo Szilard and Albert Einstein wrote a letter to U.S. president Franklin Roosevelt explaining that nuclear fission could possibly be used to make a weapon.[7] The letter says "it may become possible to set up a nuclear chain reaction in a large mass of uranium by which vast amounts of power and large quantities of new radium-like

[1] Grant. "Atomic Number 94".
[2] Nevada National Security Site. "Nuclear Timeline".
[3] Miller. "A Tale of Two Bomb Designs".
[4] U.S. Department of Energy. "Implosion Becomes a Necessity".
[5] Miller. "A Tale of Two Bomb Designs".
[6] New World Encyclopedia. "Operation Downfall".
[7] Einstein-Szilard, Letter to U.S. President Franklin Roosevelt, August 2, 1939.

elements would be generated. This phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed".[8] Many scientists around the world suspected that Germany was working on a nuclear weapon.[9] WWII started on September 1, 1939, when Germany invaded Poland.[10] The U.S. was supporting England and France but did not officially declare war until December 7, 1941, when Japan bombed Pearl Harbor[11].

President Roosevelt authorized the Manhattan Project about a month after Japan bombed Pearl Harbor.[12] The site for Project Y, the codename for atomic bomb development, in Los Alamos was not chosen until September 1942.[13] Lots of national resources were dedicated to Project Y since success of Project Y was considered critical to the success of the Allies (England, the Soviet Union, and the U.S.) in WWII. Almost two billion dollars was spent on the Manhattan Project.[14] According to the U.S. inflation calculator on the internet, this is equivalent to about 33 billion dollars in 2024.[15] The production of plutonium-239 and uranium-235 was the most expensive part of the Manhattan Project as shown in Table 1 in the Appendix.[16]

Before the Los Alamos location was chosen for Project Y, Oppenheimer and other nuclear physicists met in Berkeley, California in 1942 to brainstorm about possible nuclear weapon designs.[17] There gun-type and implosion-type of bombs were both discussed at this

[8] Einstein-Szilard, Letter to U.S. President Franklin Roosevelt, August 2, 1939.
[9] Atomic Heritage Foundation. "German Atomic Bomb Project".
[10] History. "World War II".
[11] History. "World War II".
[12] Little. "FDR's Role in Developing the Atomic Bomb".
[13] Nevada National Security Site. "Nuclear Timeline".
[14] O'Neill. "Cumulative Costs of the Manhattan Project until December 31, 1945 by Facility".
[15] Coin News Media Group. "U.S. Inflation Calculator".
[16] O'Neill. "Cumulative Costs of the Manhattan Project until December 31, 1945 by Facility".
[17] Atomic Heritage Foundation. "J. Robert Oppenheimer".

meeting, and these draft bomb designs were recorded in a notes that were later used in a short book called The Los Alamos Primer.[18] The drawings in the Appendix show the general designs of the gun-type and implosion-type bombs from the Los Alamos Primer.[19]

Concept sketches of the two bomb types in the Los Alamos Primer show that both gun and implosion bomb designs were considered initially.[20] However, the gun-type bomb was easier to make, and both original bomb designs for Little Boy and Thin Man were the gun-type.[21] The Los Alamos Primer was based on lectures by Robert Serber explaining Project Y to scientists in Los Alamos in early 1943.[22]

Designing and building the bombs was difficult. The gun-type bomb design worked by having a subcritical mass of uranium-235 or plutonium-239 fire very fast at another subcritical mass to achieve criticality and nuclear explosion. The implosion-type bomb was much harder to build because the construction and implosion timing had to be very precise. Fat Man worked by having a sphere of subcritical mass of plutonium-239 surrounded by explosives that all detonated towards the center at exactly the same time and made the sphere compress to achieve criticality.[23] Photos of Thin Man, Little Boy, and Fat Man are shown in the Appendix.

The turning point I researched was the scrapping of the Thin Man design. Thin Man was the gun-type plutonium-239 bomb that the scientists originally wanted to make, but it had several design problems.[24] The subcritical masses of plutonium-239 in Thin Man might spontaneously

[18] Serber. “The Los Alamos Primer”.
[19] Serber. “The Los Alamos Primer”.
[20] Neikirk. “Here’s Why the Manhattan Project Never Dropped the Thin Man Bomb”.
[21] Miller. “A Tale of Two Bomb Designs”.
[22] Serber. “The Los Alamos Primer”.
[23] Miller. “A Tale of Two Bomb Designs”.
[24] U.S. Department of Energy. “Implosion Becomes a Necessity”.

melt because of too many neutrons emitted from plutonium-240 causing a reaction that was too fast.[25] The subcritical masses might get too hot and melt before coming together inside Thin Man, and then the bomb would fizzle and not explode as desired.[26] Thin Man was unpredictable when it would detonate, and the pilots would not want the bomb to melt in the plane during the ride to Japan. Another reason that Thin Man did not work was that the bomb was almost 17 feet long, and only one English plane type could carry it.[27] Also, the aerodynamics of the bomb would not do well when it dropped.[28] Tests of the Thin Man casing from a modified B-29 plane showed that Thin Man could break apart and get destroyed in midair, possibly before it could detonate.[29]

In the spring of 1944 scientists realized that Thin Man would not work as they had hoped.[30] When the first sample of plutonium arrived in Los Alamos from a small reactor in Oak Ridge, Tennessee in April, scientist Emilio Segre realized that there was plutonium-240 mixed in with plutonium-239.[31] Manhattan Project chemists found out that they could not chemically separate plutonium-240 from plutonium-239.[32] The plutonium-240 would spontaneously fission at a high rate and could make the two subcritical masses of plutonium pre-detonate before they could unite in a gun-type bomb.[33] Pre-detonation means that the bomb would fizzle, or lose its

[25] Atomic Archive. “Part IV: The Manhattan Engineer District in Operation Elimination of Thin Man”.
[26] Atomic Archive. “Part IV: The Manhattan Engineer District in Operation Elimination of Thin Man”.
[27] Neikirk. “Here’s Why the Manhattan Project Never Dropped the Thin Man Bomb”.
[28] Neikirk. “Here’s Why the Manhattan Project Never Dropped the Thin Man Bomb”.
[29] Neikirk. “Here’s Why the Manhattan Project Never Dropped the Thin Man Bomb”.
[30] U.S. Department of Energy. “Implosion Becomes a Necessity”.
[31] Atomic Heritage Foundation. “Plutonium”.
[32] Atomic Heritage Foundation. “Plutonium”.
[33] Atomic Heritage Foundation. “Plutonium”.

ability to explode. The long distance between subcritical masses of plutonium-239 made Thin Man an unusable design.[34]

Plutonium-239 was produced in a nuclear reactor at Hanford, Washington starting in September 1944.[35] Plutonium-239 was not the only element produced in the reactor. One of the other elements produced was plutonium-240, and there was more plutonium-240 in the plutonium received from Hanford than in the small sample received from Oak Ridge.[36] Plutonium-240 has a short half-life and emitted more neutrons than plutonium-239, which could have caused pre-detonation in a gun-type weapon.[37]

Oppenheimer realized that the Thin Man design had too much potential to fail, especially after he learned about the problem with plutonium-240 poisoning from Segre.[38] Oppenheimer had a few options at this point. He could have resigned as director of Los Alamos Lab, or he could have put all of the research efforts into improvements to Little Boy, or he could pursue the implosion concept that the scientists had thought of before the Manhattan Project began.[39] Oppenheimer and the Manhattan Project scientists believed that the plutonium implosion weapon would be more efficient than the uranium gun-type bomb, so Oppenheimer chose to pursue implosion research.[40] Choosing the implosion bomb design also meant that all the work already done to start producing plutonium-239 would not be wasted.[41]

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[34] Atomic Heritage Foundation. “Plutonium”.
[35] Atomic Heritage Foundation. “Timeline”.
[36] Atomic Heritage Foundation. “Plutonium”.
[37] Atomic Archive. “Part IV: The Manhattan Engineer District in Operation Elimination of Thin Man”.
[38] U.S. Department of Energy. “Implosion Becomes a Necessity”.
[39] Alan Carr, personal interview by Brandon Keller, White Rock, New Mexico, May 2, 2024.
[40] Alan Carr, personal interview by Brandon Keller, White Rock, New Mexico, May 2, 2024.
[41] Miller. “A Tale of Two Bomb Designs”.

The turning point I researched happened in July 1944 when Oppenheimer stopped all work on Thin Man and reorganized the Los Alamos Laboratory to focus on creating an implosion weapon with plutonium-239.[42] This was not an easy task since Oppenheimer had to move people into new jobs and reassign people to different jobs.[43] Oppenheimer created G (Gadget) Division to design a plutonium-239 implosion-type bomb and X (Explosives) Division to work on the explosive parts that would crush the core.[44] Reorganizing the Los Alamos Lab to start a completely new project under significant time pressure was a difficult choice.

Scrapping the Thin Man bomb design in favor of the Fat Man bomb meant losing over a year of work. Getting the Fat Man design to work was critical since not enough uranium-235 could be made quickly. The Little Boy bomb needed about 140 pounds of uranium-235 and had a yield equivalent of about 15,000 tons of dynamite.[45] Fat Man had a yield equivalent of about 21,000 tons of dynamite and used about 14 pounds of plutonium-239.[46] The yield estimates show that Fat Man was a much more efficient weapon than Little Boy.

A complete Little Boy bomb was never tested before its use on Hiroshima, Japan on August 6, 1945 since the Manhattan Project scientists felt sure that it was a reliable design.[47] Another reason the scientists did not test Little Boy was because there was not enough uranium-235 to make another bomb right away. The Manhattan Project only had enough uranium-235 for Little Boy because it was a very slow process to separate uranium-235 from uranium-238 in Oak

[42] Atomic Heritage Foundation. “Timeline”.
[43] Alan Carr, personal interview by Brandon Keller, White Rock, New Mexico, May 2, 2024.
[44] U.S. Department of Energy. “Implosion Becomes a Necessity”.
[45] Atomic Heritage Foundation. “Little Boy and Fat Man”.
[46] Atomic Heritage Foundation. “Little Boy and Fat Man”.
[47] Neikirk. “Here’s Why the Manhattan Project Never Dropped the Thin Man Bomb”.

Ridge, Tennessee.[48] Plutonium-239 could be produced much faster, and much less of this material was needed for a bomb, so the Fat Man type of bomb was more important to the war effort. Once the reactor to produce plutonium-239 started running in Hanford, Washington in September 1944 it was faster and easier to get plutonium-239 to make a new weapon.[49]

The Fat Man design was more complex, and it was unknown if the implosion design would work.[50] Oppenheimer wanted to test the implosion-type bomb without the bomb case, nicknamed The Gadget, within the U.S. in case it failed, so the preparations to test The Gadget started soon after Oppenheimer reorganized Los Alamos Lab.[51] About a year later, the test of The Gadget on July 16, 1945 at the Trinity Site in southern New Mexico was a success.[52] Instead of being dropped from an airplane, The Gadget was dropped from a 100-foot firing tower.[53]

Four scientists from the Manhattan Project were on a science panel that wrote a letter to the Interim Committee, which was set up in May 1945 to give recommendations on how to use atomic weapons in war.[54] On June 16, 1945 Oppenheimer signed a letter for the science panel recommending that the atomic bombs be used against Japan to end WWII and hopefully prevent future wars.[55]

U.S. President Harry Truman wanted to use the bombs because that was expected to save many lives compared to the planned invasion of Japan (Codename Operation Downfall). The invasion of Japan was set for December 1945, and it was estimated that 6-14 million people

[48] U.S. Department of Energy. "The Uranium Path to the Bomb 1942-1944".
[49] U.S. Department of Energy. "The Uranium Path to the Bomb 1942-1944".
[50] U.S. Department of Energy "Implosion Becomes a Necessity".
[51] U.S. Department of Energy. "The Trinity Test".
[52] U.S. Department of Energy. "The Trinity Test".
[53] U.S. Department of Energy. "The Trinity Test".
[54] Atomic Heritage Foundation. "The Interim Committee".
[55] Atomic Heritage Foundation. "The Interim Committee Report".

might die if the Allies had invaded Japan.[56] Invading Japan might have taken another two years for the Japanese to surrender without using the atomic bombs.[57] Another reason the U.S. used the atomic bombs instead of waiting for the Soviet Union to invade Japan was so the U.S. could show dominance.[58] The Soviet Union declared war on Japan on August 8, 1945, and the U.S. did not want the people of the world to believe that the Soviet Union's declaration of war was the reason why Japan finally surrendered.[59]

On July 26,1945, U.S. President Truman issued the Potsdam Declaration asking for Japan to surrender unconditionally and end WWII. The declaration ended with "The alternative for Japan is prompt and utter destruction".[60]

After The Gadget was proven at Trinity Site, Fat Man was used in combat less than one month later. On August 6, 1945 Little Boy was dropped on Hiroshima, Japan, and Fat Man was dropped on Nagasaki, Japan on August 9, 1945 from B-29 airplanes.[61] Japan announced its intention to surrender on August 15, 1945 and signed a peace treaty on September 2, 1945.[62] The detonation of Fat Man ended almost six years of war.[63] If the Los Alamos scientists had worked on the implosion bomb design from the beginning, they might have finished the bomb about a year earlier. If the scientists had Fat Man ready sometime in 1944, the U.S. might have bombed

[56] New World Encyclopedia. "Operation Downfall".
[57] New World Encyclopedia. "Operation Downfall".
[58] New World Encyclopedia. "Operation Downfall".
[59] New World Encyclopedia. "Operation Downfall".
[60] Truman Library Institute. "The Potsdam Declaration".
[61] Nevada National Security Site. "Nuclear Timeline".
[62] Miller. "A Tale of Two Bombs".
[63] New World Encyclopedia. "Operation Downfall".

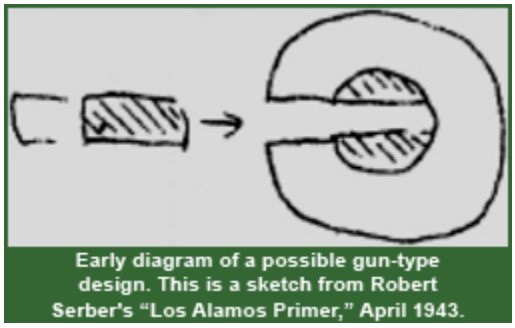
Germany with Fat Man since the plutonium-239 was ready in Los Alamos in February 1945.[64] Germany did not surrender until May 1945.[65]

More bombs like Fat Man were to come since that design was much more efficient than Little Boy.[66] The U.S. tested these new implosion-type bombs on small islands and at a test site in Nevada.[67] Over time the bomb designs improved, and the bombs became more powerful. Since WWII, over 2,000 nuclear bombs have been dropped in research tests. No nuclear bombs have been tested underground in the U.S. since 1992.[68]

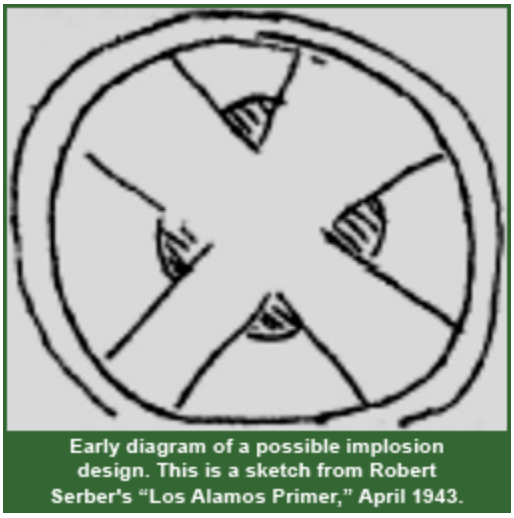
In conclusion, if the scientists of the Manhattan Project had pursued the implosion design in 1943 along with the gun design, the Allies might have bombed Germany. This would have been a significant change in history. If the implosion bomb had not been pursued, it is uncertain that Japan would have surrendered as quickly after being hit with one nuclear bomb as they did after being hit with two nuclear bombs. Switching from Thin Man to Fat Man might have been Oppenheimer's hardest decision as Los Alamos Lab's director during the Manhattan Project and also the decision with the most historical impact.

[64] Atomic Heritage Foundation. "Plutonium".
[65] History. "World War II".
[66] Atomic Heritage Foundation. "Little Boy and Fat Man".
[67] Nevada National Security Site. "Nuclear Timeline".
[68] Nevada National Security Site. "Nuclear Timeline".

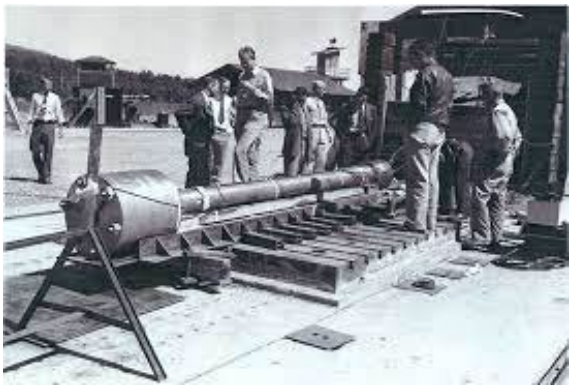
Appendix



Early diagram of a possible gun-type design. This is a sketch from Robert Serber's "Los Alamos Primer," April 1943.

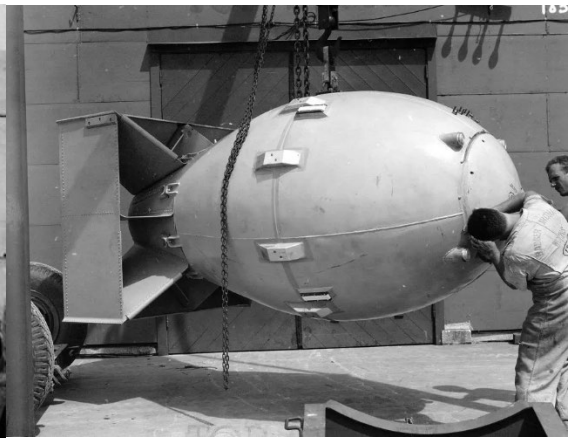


Early diagram of a possible implosion design. This is a sketch from Robert Serber's "Los Alamos Primer," April 1943.



Thin Man (Miller)

Little Boy ("Early Bomb Design")



Fat Man ("Developing the Atomic Weapons")

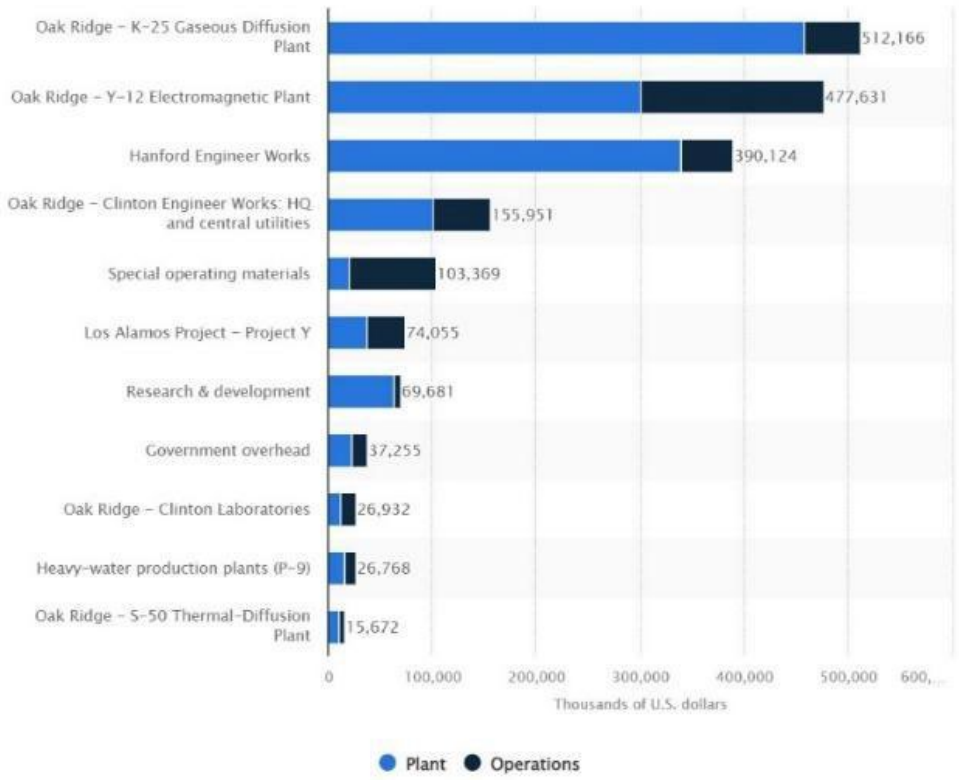


Table 1 – Cumulative Costs of the Manhattan Project (O'Neill)

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I interviewed Alan Carr, the Senior Historian at Los Alamos National Laboratory to get information on options that Oppenheimer had when he realized that Thin Man would not work. Alan Carr also provided the number of employees in G Division and X Division at the end of WWII.

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