The Manhattan Project: Then and Now

…it became evident that sooner or later some country would make an atom bomb.

-Joseph O. Hirschfelder, 1980

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Introduction

On December 17, 1938 Otto Hahn, a German chemist, bombarded a sample of uranium with thermal neutrons, detecting barium in the process[1]. With this, nuclear fission was discovered. After World War II, Hahn received the Nobel Prize for his discovery. In 1939, the groundwork was laid for American research in nuclear fission. By 1941 a concerted effort was made to apply experimental discoveries to real-world military applications. The Manhattan Project was born in 1942. The goal of this top-secret endeavor was the production of an atomic bomb, a feat that had been believed to be impossible just a few years earlier. This goal became reality on July 16, 1945 with the successful detonation of an implosion-based plutonium bomb, nick-named "the gadget," in Alamogordo, New Mexico[2].

This scientific achievement was a modern wonder and represented the culmination of science and engineering truly on the cutting edge. However, with this achievement came unforeseen consequences and impacts on society. Thousands of people were either dead or injured in a flash when the bombs were detonated over Hiroshima and Nagasaki in August 1945. The lingering radiation impacted the residents' health for years to come[3]. The time after WWII also brought about an intense arms race between the US and the USSR, based on fear.

Today (2009), nuclear technology and weapons remain at the forefront of government concerns. Extreme measures including economic sanctions and bombings are taken to keep some countries from obtaining the capability to construct atomic bombs. Recently there has been a renewed push for the elimination of nuclear weapons altogether. The US and Russia are currently leading the way for international policies that one day we may live in a world without potential mutual destruction.

The Manhattan Project

1. Leó Szilárd

Leó Szilárd was a prominent Hungarian physicist of Jewish descent. After receiving his doctorate in Berlin in 1932, he moved to London in 1933 due to persecution by the Nazis[4]. Incensed by an article written by the world-famous British physicist Ernest Rutherford dismissing the idea of harnessing atomic energy, Szilárd conceived the idea of an atomic chain reaction[5], and began experimenting with beryllium and indium but had little success.

2. The Einstein-Szilárd letter

Following the discovery of fission, in 1939, Szilárd, with the help of former UC Berkeley professor of physics, Edward Teller, drafted a secret letter to President Franklin D. Roosevelt, signed by Albert Einstein[4]. This letter warned of the possibility of research by the Germans concerning nuclear fission for bombs, and recommended expediting American research. The letter read:

> *"…it may be 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 elements would be generated… This new phenomenon would also lead to the construction of bombs…"*

Upon receiving the letter, Roosevelt created the *Advisory Committee on Uranium* to advise him on what action the government should take[6]. The committee recommended limited funding for isotope-separation research, in addition to Szilárd's work on chain reactions[7].

3. The Office of Scientific Research and Development

Until 1940, work on the bomb was slow and lacked overall coordination. With the help of Ernest O. Lawrence, director of the Radiation Laboratory at UC Berkeley, The National Academy of Sciences prepared two reports for top

administration officials. The reports concluded that there was little evidence that uranium research would pay off if the United States went to war and the production of a bomb before 1945 was impossible[8].

Due to discouraging prospects, *The Office of Scientific Research and Development* was created on June 28, 1941[9] with the sole purpose of advancing scientific research for real-world military applications. The original *Advisory Committee on Uranium* was enveloped into this new, more powerful organization, and was given the code name "Section S-1"[9].

4. Section S-1

The entrance of the United States into WWII after the December 7, 1941 attack on Pearl Harbor in Hawaii, increased the push for production of a bomb. S-1 now had rough guidelines as to the quantities of radioactive material needed and multiple potential methods of production, including electromagnetic isotope-separation, developed by Professor Lawrence.

In May 1942, the group leaders of S-1 met to discuss all aspects of planning and construction of the bomb. Because no one isotope-separation technique was clearly better than the others, it was decided that all production methods would continue on to the pilot-plant phase, and ultimately, to full production[10]. This decision underscored the grave importance placed upon obtaining a bomb.

5. Code Name Manhattan

With the need for ever-increasing secrecy, the responsibility for Section S-1 was transferred to the Army Corps of Engineers. An executive committee was created to oversee the technical work that would provide support for reaching engineering decisions, while the main construction effort was run by the Army.

This conglomerate, now headed by Colonel (later, General) Leslie R. Groves, was referred to as The Manhattan Project[10].

6. Los Alamos[11]

With the bulk of the work performed at universities across the country, security became an important issue. Oppenheimer (the scientific director) met with Colonel Groves to discuss the creation of a centralized, secret research facility. In late 1942, Oppenheimer and Groves settled on the site of a private boys' school just outside Santa Fe, New Mexico. The Los Alamos Ranch School was quickly bought and converted into Oppenheimer's secret research facility. Los Alamos produced three atomic weapons: the first one was tested at the Trinity site in New Mexico in July 1945. "Little Boy" and "Fat Man" were constructed at Los Alamos following the successful test at Trinity.

7. "Little Boy" and "Fat Man" [12, 13]

"Little Boy" was constructed first. It operated by firing a cylindrical, hollow uranium^{235} "bullet" using chemical explosives at a second solid uranium cylinder, which would initiate the chain reaction. It weighed 8,900 lbs. and was estimated to be equivalent to 12-15 kilotons of conventional TNT. Final assembly was completed on Tinian Island (200 miles north of Guam) on August 1, 1945.

"Fat Man" weighed 9,000 lbs. This bomb relied on a solid spherical core of plutonium that was inwardly compressed by the detonation of conventional explosives surrounding the core. This bomb had the power of approximately 22 kilotons of TNT and was also assembled on Tinian Island in early August.

Significance Then

1. *During WWII*

After the fall of Nazi Germany (May 8, 1945), allied leaders met in Potsdam, threatening "prompt and utter destruction" if Japan did not surrender unconditionally[14]. Fearing the cost and possible American death toll of an invasion of Japan, allied forces decided to drop atomic bombs on Japan. The first was "Little Boy," dropped on Hiroshima August 6, 1945. Approximately 74,000 people were killed with a similar number injured[12].

With no surrender from the Japanese, "Fat Man" was dropped on Nagasaki August 9th,[15] killing 39,000 and injuring another 25,000[13]. Japan surrendered August 15, 1945[15].

The bombs brought an end to the war, but they also created destruction of unparalleled proportions. Never before had cities been wiped out so effortlessly. Tens of thousands of innocent civilians were killed or injured by one bomb. Those who survived have continuous pain and horrific memories. Sumiteru Taniguchi, who was delivering mail at the time of the bombing of Hiroshima, has burns to this day. Parts of his ribs are fused to his skin. His bones are so brittle that if he coughs, they could break. He says: *"I've shown you my wounds because I want you to know this can't happen again"*[17]. Upon touring Nagasaki in September 1945, the reporter, George Weller, wrote: *"Some adults are in pain as they lie on mats. They moan softly. One woman caring for her husband, shows eyes dim with tears. It is a piteous scene…"*[18].

2. *American Perspective*

Some Americans, in particular, President Truman, believed that the bombs provided the only solution to end the war. Joseph O. Hirschfelder, a prominent

chemist and member of The Manhattan Project said: *"At Los Alamos during World War II, there was no moral issue with respect to working on the atomic bomb… our friends and relatives were being killed and we, ourselves, were desperately afraid"*[19]. George B. Kistiakowsky, another chemist working on the project echoed those sentiments by saying: *"…the atom bomb is no worse than the fire raids which our B-29s were doing daily in Japan, and anything to end the war quickly was the thing to do"*[19].

Not all Americans shared these sentiments, however. Dwight Eisenhower, upon being told by the Secretary of War that the bomb would be used, remembered: *"During his recitation of the relevant facts, I had been conscious of a feeling of depression and so I voiced to him my grave misgivings…"*[20] Even Einstein himself, who signed Szilárd's letter to President Roosevelt, was said to have later regretted it[21].

3. *Robert J. Oppenheimer*

Oppenheimer started teaching physics at UC Berkeley in 1929. In the early 30's, Oppenheimer began collaborating with Ernest Lawrence on Lawrence's cyclotron work[21]. It was during this time that Lawrence recognized Oppenheimer's brilliance. Upon Lawrence's invitation in early 1941, Oppenheimer became involved in fast-neutron research for S-1[21]. Once the project became known as The Manhattan Project, General Groves chose Oppenheimer to be the scientific director[21]. While firmly involved in the development of the bomb, Oppenheimer started having doubts after witnessing the first nuclear explosion, "Trinity," on July 16, 1945. Oppenheimer recounted:

"We knew the world would not be the same. A few people laughed, a few people cried. Most people were silent"[22].

After the war, Oppenheimer was appointed Chairman of the General Advisory Committee to the Atomic Energy Commission[23]. Using this position, Oppenheimer became a staunch supporter for international arms control, because he saw an impending nuclear arms race between the United States and the USSR.

When the government began to debate whether or not to pursue development of a hydrogen bomb, Oppenheimer initially recommended against it due to moral and technical reasons, as there was no working design for a bomb. In 1951, however, Edward Teller, in conjunction with the mathematician Stanislaw Ulam, developed a design for such a weapon. Oppenheimer decided to support this development, on the grounds that the USSR was probably doing the same[25].

Oppenheimer made many enemies over the course of his career. Because of possible communist sympathies in the 1930's, some people felt Oppenheimer's security clearance should be revoked[25]. Edward Teller, Oppenheimer's colleague from UC Berkeley, shared these sentiments. Teller resented that Oppenheimer did not fully support his push for development of thermonuclear weapons, such as the hydrogen bomb, but instead, lobbied for smaller weapons.

At Oppenheimer's security clearance hearing, Teller testified that although he believed Oppenheimer loyal to the United States, he lacked the judgment necessary to have clearance, saying: *"If it is a question of wisdom and judgment, as demonstrated by actions since 1945, then I would say one would be wiser not to grant clearance [to Oppenheimer]"*[26]. Oppenheimer's security clearance was

eventually revoked, although only one day before it was scheduled to end[27]. Teller's testimony alienated him from the academic community. As a result, after the early 1950's Teller worked more in government as a lobbyist and adviser. Teller retired from UC Berkeley in 1975[28].

Significance Now

1. Overview

Today there are approximately 31,000 nuclear warheads around the world[29]. As of 2002, The United States had 10,600 weapons[30]. Nuclear weapons are consistently at the forefront of government policy and have dictated much of US foreign policy since 1945. The prospect of mutually-assured destruction (MAD) has kept any country from using a nuclear device, but there is concern that some countries may fail to exercise restraint if they were to obtain the capability to make nuclear bombs.

2. Iraq

On March 20, 2003, Iraq was invaded because of fear that Iraq had weapons of mass destruction (WMD)[31]. The United States, the U.K. and Spain claimed that Iraqi nuclear capability was an "imminent" threat to their security, and that of their allies[32]. The thought of Iraq having such weapons was enough to justify the war.

As of late 2008, The United States alone has paid close to one trillion dollars for the Iraq war. Some claim that the war contributed to the economic downturn, and is hindering subsequent recovery, according to the Nobel Prize-winner, Joseph Stiglitz[33]. To put this in perspective, $1 trillion could finance four years of college for 43 million students[33].

3. Iran

The UN believes Iran, if allowed to gain nuclear capabilities, would present an unacceptable danger. Since 2006, the UN has lobbied for many sanctions against this country; starting with Resolution 1696 in June, which demanded the suspension of Iran's enrichment program and offered economic incentives. When Iran did not comply, Resolution 1737 was passed in December 2006, imposing a complete ban on trade with Iran, as well as the freezing of assets believed to be funding the program. This was followed up by Resolution 1747 in early 2007 banning all imports and exports of arms, as well as widening the freeze on financial assets[34]. This continued trouble and worry is an unhappy consequence of the events of August 6th and 9th, 1945.

4. Reduction Efforts

In early 2009, President Obama met with Russian president Medvedev to discuss arm reductions, specifically agreeing to a new treaty which could cut both countries' arsenals by 80%[35]. This was followed by another meeting on April 2, 2009, in which Obama and Medvedev agreed to renegotiate treaties designed to reduce each nation's nuclear stockpiles. A joint Statement by Obama and Medvedev stated: *"As leaders of the two largest nuclear weapons states, we agreed to work together… We committed our two countries to achieving a nuclear free world…"*[36] Additionally, Obama has even expressed his dreams of a nuclear-free world, saying: *"The United States will take concrete steps toward a world without nuclear weapons"*[37].

Conclusion

The harnessing of nuclear fission in 1945 to make an extremely powerful weapon was a scientific masterpiece with unparalleled cultural implications. Use of this weapon led to an unsurpassed level of destruction at the time. While it ended WWII, it also influenced the Cold War and an intense arms race between America and its perceived enemies, a period marked by collective fear and anxiety. Today the threat of new countries gaining nuclear technology is on the rise. With renewed cooperation between the US and Russia, however, there may be hope for the reduction and perhaps, elimination of nuclear weapons.

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