America's Greatest Projects and Their Engineers II

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America's Greatest Projects & Their Engineers-II

The Manhattan Project

Introduction

A lot has been made about the fact that the two atomic bombs dropped over the Japanese cities of Hiroshima and Nagasaki, while they likely brought a quick end to World War II, also killed nearly 130,00 Japanese civilians as well as an estimated 20,000 Japanese soldiers. Unless your Uncle Tony was a part of the U. S. Infantry that battled the Japanese in the Pacific Theater and suffered the trauma and deprivation at the hands of the heinous Japanese military, you might wonder if there could have been a better (more humane) way to end the war. Indeed, that is a fair question to ask about the carnage that was wreaked on the mostly innocent Japanese population. However, this course deals with the achievements and successes of the many engineers and scientists who put their lives on temporary hold in order to assure that the worst criminal in world history, Adolph Hitler, would never have the opportunity to reign supreme. The Japanese, because of the arrogance and stubbornness of their military leaders, became the unwitting victims of American determination and ingenuity.

This course traces technological events leading up to the dropping of the first two atomic bombs on Japan, including the ideas and the attempts by other nations to develop similar weapons that could ultimately make them the world's strongest military powers. Course describes efforts of many individual U. S. engineers and scientists to achieve this engineering feat.

Outline

A. Early Events

B. The United States Plan

C. U. S. Race to Completion

D. Result/Summary

A. Early Events

Beginning of Hitler's Reign

Hitler had come into power in Germany in early 1933 as the leader of the Nationalist Socialist (Nazi) Party, and almost immediately adopted two objectives:

1. Rid Germany (Deutschland) of Jews and take their money and possessions.
2. Conquer all of Europe between Russia and the Atlantic Ocean.

Interestingly Hitler came into power as the chancellor of Germany at the same time that Franklin D. Roosevelt became President of the United States. The Great Depression was at its height and affected unemployment throughout the world. President Roosevelt did his best to reduce unemployment, inaugurating numerous conservation and social programs during the 1930's, one of which we discuss in a previous course. Nevertheless, Roosevelt had little success in reducing the high unemployment rate in the United States. Hitler on the other hand was successful over a period of five or six years in reducing the unemployment rate in Germany by nearly 85% through the purging of Jews and other minorities and the implementation of other nefarious actions. While Hitler was wreaking havoc in Eastern and Western Europe, British and American leaders tried to ignore his activities, placate his actions, and remain neutral.

Hitler's plans for putting the German population back to work were far more ruthless than most civilized nations could fathom. By ridding Germany of its Jewish population and confiscating their vast resources of wealth, Hitler was able to have access to hundreds of millions of marks in order to build up his military machine. In addition, he dissolved all union activities, requiring all workers to join and pay dues to his National Socialist Party, used forced labor where necessary, and socialized all businesses and manufacturing facilities so that all profits flowed into his government treasury. During the period from 1936 through 1938 he also eliminated any dissension in his military ranks by removing and imprisoning any generals who took an opposing viewpoint to his genocidal policies.

A. Early Events

Germany in the 1930's had some of the great minds in the engineering and science fields, including Otto Hahn and his assistant Fritz Strassmann. They discovered that the uranium atom when bombarded with neutrons would actually split. Hahn studied industrial chemistry and worked in Montreal and London for several years before finally returning to the University of Berlin. While in Berlin Hahn teamed up with Lise Meitner, a Jewish physicist from Austria and one of the few women in all of Europe with a Ph. D. During the 1930's these three were dedicated to identifying the products of neutron bombardment of uranium and what higher - numbered elements would be created.

Unfortunately, Dr. Meitner had to leave Berlin suddenly in 1938 because the Nazis were placing into captivity all known or suspected Jews, and she found a safe haven in Copenhagen. While there Dr. Meitner and her nephew Otto Robert Frisch named the process **nuclear fission** by analogy with biological fission living cells, describing it as an exothermic reaction which was capable of releasing large amounts of energy in both kinetic energy form as well as electromagnetic radiation. News of the splitting of the atom was made known in the United States in early 1939, which captured the imaginations of engineers and scientists in the U. S. and around the world. At that time the simple explanation was that in order for fission to produce energy, the total binding energy of the resulting elements must have higher energy than that of the starting element.

Almost ironically as well as fortuitously, none of these scientists ever became engaged in nuclear weapons research during World War II. Dr. Hahn later won the Nobel Prize for chemistry in 1944, and was genuinely surprised that not only had he won the award for his discovery but also that nuclear bombs had been developed from the discovery.

Leo Szilard, Physicist

Physicists and scientists in the U. S. and Great Britain had grave concerns regarding the discovery of nuclear fission in Germany in 1939. Leo Szilard, a displaced physicist from the University of Berlin was one of several physicists and scientists who were very vocal about the possibility that the Germans might be the first to build an atomic bomb. Szilard was a Hungarian Jew who had been born in Budapest, started out as a Civil Engineering student, then switched majors to study physics at the University of Berlin. There he worked and collaborated with such notables as Albert Einstein and Max Plank.

Szilard left Germany in 1933 due to the rise of Hitler and the Nazis in Germany and the beginnings of their anti-Semitic policies. He first studied and worked at Oxford University in London before moving to the United States in the late 1930's to accept a teaching position at Columbia University. At that time Szilard joined with several other scientists to formulate a letter detailing their experiments that had resulted in creating vast amounts of energy by bombarding uranium with neutrons, and were leery that the Germans would use the technology to build an atomic bomb. They then convinced Einstein, a Jew who had been in the U. S. since the rise of Hitler in 1933, to write a letter to President Franklin D. Roosevelt concerning the possibility that the Germans would be able to build an atomic bomb. Roosevelt received the letter shortly after the Germans invaded Poland, took the matter seriously, and convened a meeting with Szilard, Einstein, and several of his military aides. Even though war would not be declared on the U. S. by Germany for another two years, and despite the skepticism of his military that a bomb could ever be created out of uranium, Roosevelt formed a board for the purpose of investigating whether transforming atomic energy into a bomb for military purposes could be achieved. To the president's credit, he listened to his experts and had the foresight to acknowledge their concerns.

Maintaining Neutrality

While Hitler continued to build up the vast German army and to enter into alliances with Japan and Italy, the other world powers consisting of America, Great Britain, and France continued to remain neutral. Continuing his objective of mastering all of Eastern and Western Europe, Hitler annexed Austria to Germany in the spring of 1938. After signing a non-aggression treaty with France and Great Britain, he promptly broke that accord by invading Czechoslovakia in March of 1939. Later that year he signed an accord with Russian Dictator Josef Stalin whereby Russia would attack Poland from the east, with Germany taking over the western half of Poland and Russia the eastern half. Since both Great Britain and France had guaranteed Polish sovereignty, this was a risk that Hitler was apparently willing to take. When Germany invaded Poland in early September of 1939, both Western European countries immediately declared war on Germany, which was the official start of World War II. When Russia invaded Poland from the other side two weeks later, the same two nations also declared war on Russia.

The Nazi Blitzkrieg continued in 1940, with Germany invading Norway and Denmark in April and France and Belgium in May. Within five weeks of the German invasion, the French signed an armistice of sorts with Germany, which gave the German military access to all of France as well as a foothold on the western shore of the English Channel. Only Great Britain, partly because of their remoteness to the European continent and partly because of their tenacious leader Winston Churchill, was able to resist the German occupation. The German Luftwaffe bombed London and other major cities in England mercilessly for several months, but the English never wavered.

Following the invasion of France and realizing the well-known fact that millions of Jews as well as hundreds of thousands of Poles and Slavs were being enslaved, tortured, and killed, the United States began acting on several fronts. Roosevelt had formed an investigative board following the revelation that German engineers and scientists had discovered a potential weapon that could alter the power structure of the entire world. While on the surface the United States seemed determined to avoid any conflict with Germany, the U. S. was initiating several other activities that would prepare the country for war while concurrently exploring the possibility of an atomic bomb.

In June, 1940 Roosevelt established the National Defense Research Committee with Vannevar Bush as its chairman. Bush and a team of academics, as well as representatives from both the U. S. Navy and the U. S. Army were responsible for pursuing wartime projects that were non-lethal in nature. The committee set up a laboratory at MIT, and developed such leading-edge technologies as a general-purpose digital electronic computer and a mobile radar fire control system for antiaircraft guns.

At the specific urging of Bush, Roosevelt formed the Office of Research and Scientific Development in June, 1941. The ORSD, with Bush as its director, was funded by Congress and had the authority to develop weapons and technologies with or without military approval. Part of the ORSD's responsibility under Bush was to brief the president on the progress with uranium enrichment and to also give an account of the recently initiated British atomic bomb project. To control the U. S. project Roosevelt created another group that included Vice President Henry A. Wallace, Secretary of War Henry Stimson, Chief of Staff of the Army General George Marshall, and Bush. He later rejected the notion of a joint atomic bomb research project with the British, considering it to be a potential security risk.

Vannevar Bush

Vannevar Bush was born in Everett, Massachusetts in 1890. He attended Tufts University, where he received both his Bachelor of Science and Master's degrees in 1913, already having patented his first of numerous inventions. He received his doctorate in electrical engineering jointly from both MIT and Harvard. Bush was known for his early work in analog computers, and founded the company now known as Raytheon when he was thirty-two years old. He spent a considerable amount of his early career at MIT, where he became vice president and dean of the MIT School of Engineering in 1932.

Bush initially moved to Washington, DC in 1938 as president of the Carnegie Institution of Washington, and later became chairman of the National Advisory Committee for Aeronautics. He was appointed by President Roosevelt as chairman of the National Defense Research Committee, and coordinated the activities of more than six thousand engineers and scientists in various warfare applications. Bush was named as director of the Office of Scientific Research and Development, and his diplomacy and initial planning helped to establish the beginnings of the atomic bomb research efforts. His familiarity with American physicists and chemists was a key ingredient in the preparation of the necessary programs to provide atomic bomb making materials. Bush supported the U. S. Army over the U. S. Navy in pursuing the atomic bomb project, and expressed his concern that the federal government was not giving the project a top priority. Furthermore, his anxiety was exacerbated when the responsibility for the project was assigned to Leslie Groves, a mere colonel in the U. S. Army at the time.

Bush continued to drive the atomic bomb project in 1942, bringing in new research personnel such as Robert Urey from Columbia, but there was indecisiveness over how many pilot plants should be constructed and where they should be built. He remained perturbed by the lack of priority given to the project, which he felt would delay the implementation and testing of the project by several months. The final action by Bush occurred at a meeting with Major General Brehon Somervell, the commander of the Army's Service and Supply Construction Division. At that meeting in September of 1942, Somervell had appointed then Colonel Leslie Groves, who was about to be promoted to Brigadier General, as the project director, citing his abilities to "get the job done". Somervell mentioned two of Groves' recent projects, attributing the success of the military camps and the Pentagon Building to Groves. Although Bush was not necessarily opposed to Groves personally, he felt that the bomb project should be assigned to a civilian organization rather than to the U. S. Army. Groves later impressed Bush with his significant capabilities when he was able to convince the federal government within a few weeks of the project's beginning to assign a top priority (AAA) to the project.

Even though Vannevar Bush was not directly involved in the making of the atomic bomb, his early preparedness and his diplomacy in insisting that the project would receive highest government priority were major factors in the ultimate success of the project. Bush was present at the first atomic test in July, 1945, and became part of a committee to advise new president Harry S. Truman on nuclear weapons. Bush remained in government service for several more years following the end of World War II, receiving many awards in the U. S. and abroad for his distinguished service. He returned to private business after 1950, although he retained a certain amount of pride in his role as the initiator of the atomic bomb project until his death in June, 1974.

Preparing for Inevitable War (with Germany)

The impetus for America getting serious about the German threat likely took on new meaning in late 1939 following the invasion of the Germans and the Russians into Poland. Following World War I, the American military forces had gradually been depleted, including a U. S. Navy that couldn't come close to competing with either the British or the German navies. The U. S. Air Force, a part of the U. S. Army Air Corps, was virtually non-existent. Amid this depressed state of affairs, the U. S. Army under the direction of President Roosevelt, embarked on a national mobilization of the military. Roosevelt, who was about to be elected to an unprecedented third term as president of the United States, had two objectives:

1. The U. S. needed a military to confront Hitler's forces if America were invaded.

2. He had seen how Hitler's military buildup had brought Germany out of a deep recession.

In the spring of 1940 the burden was placed on the Construction Division of the U. S. Army Corps of Engineers to prepare training facilities and living accommodations for the large army that would be created. This was an enormous undertaking, and it was plagued from the start by poor planning, lack of materials, and numerous construction delays. National newspapers began to publish critical accounts of the activities, citing the three common "in's": inefficiency, incompetence, and ineptitude.

Leslie Richard Groves, a major who was on the general staff of the War Department in Washington, DC at the time, was one of the engineering officers who was assigned to the task of turning the project around. Groves had a reputation as a stickler for duty, a doer, and someone who would figure out a way to get things done. In November of that year he was promoted to colonel and was basically placed in charge of setting up all of the camps and barracks necessary for the more than two million military men who would inhabit those camps. Groves, who was now essentially the Project Director for the entire project, instituted programs that today's quality Project Managers take for granted:

a. Communications - phone lines at each location to instantly resolve any problems
b. Reports - weekly activity and progress reports
c. Expediters - at each location to report shortages and procure materials
d. Schedules - work priorities and completion dates

Grove's planning was a great reason that the U. S. was at least partially prepared to handle the early combat operations when war was finally declared. Had this been Groves' only achievement in his military life, he would have received many awards. However, there was to be a lot more.

In August, 1941 Hitler continued his bombing assaults on London and other English cities. His troops invaded small, helpless countries such as Greece and Crete, and pushed through Yugoslavia in short order. His generals established death camps at Auswich and several locations in Poland and the Balkans as part of Hitler's ideology to "cleanse" the Aryan race, where more than six million Jews and at least five million other ethnic groups were being starved, gassed and otherwise slaughtered. Later that year his nearly five million troops marched to within 300 miles of Moscow in an attempt to secure Russia's natural resources, primarily the oil that Germany desperately needed. Their efforts were eventually thwarted when Hitler made a strategic mistake, and the German army was resoundingly defeated in the winter of 1941.

In the meantime, Colonel Groves was summoned on 19 August 1941 to a meeting by Brigadier General Brehon Somervell, head of the U. S. Army Construction Division. At the meeting were George Bergstrom, former president of the American Institute of Architects, Major Hugh Casey, Chief of the U. S. Army Corps of Engineers Design and Engineering Section, and Captain Clarence Renshaw, an associate of Groves. Casey and Bergstrom had been instrumental in the design of a five-sided office complex that would ultimately be called the "Pentagon." It was to be constructed by the spring of 1942 and was to be the headquarters for the War Department's 40,000 staff members. It would become the largest office building in the world, and would have more than twice as much office space as the Empire State Building.

Brigadier General Leslie Richard Groves

Leslie Richard Groves, a native of Albany, New York, was the son of a U. S. Army chaplain and was appointed to West Point in1916. Due to World War I his education was shortened, and he graduated fourth in his class with a commission of 2nd Lieutenant. Groves, like most of the higher rated cadets, was assigned to the U. S. Army Corps of Engineers. Following World War I Groves was posted to numerous engineering duties, including the 7th Engineers at Ft. Benning, Georgia, the 4th Engineers at Ft. Lewis, Washington, and the 3rd Engineers at the Schofield Barracks in Hawaii.

In November, 1925 he was posted to Galveston, Texas, as an assistant to the District Engineer, where his duties included supervising the opening of the channel at Port Isabel and dredging operations in the Galveston Bay. Groves was sent to assist with a detachment of the 1st Engineers at Ft. Ethan Allen, Vermont, escaping blame for an accident that seriously injured several of his men, one fatally, when a block of TNT prematurely exploded. Cleared of any liability on his part, in 1929 he was assigned a company of the 1st Engineers and was sent to Nicaragua, where he became responsible for the city of Managua's water supply following a major earthquake. He was awarded a Medal of Merit by the president of Nicaragua, and was promoted to captain.

He attended General Staff School at Fort Leavenworth, Kansas, after which he was posted as an assistant to the commander of the Missouri Division in Kansas City. Groves was one of the first U. S. Army members who sensed that war was becoming more imminent with the Germans, who appeared to be preparing to seize large portions of eastern and Western Europe. Groves attended the Army War College in Carlisle, PA, in 1938 and 1939, preparing for a combat role in the event that war should be declared. In July of 1939 he considered himself fortunate, so he thought, to be posted to the general staff in the War Department in Washington, DC., although he was eventually assigned to the Construction Division of the Quartermaster Corps in Washington, DC in 1940.

George Bergstrom, A. I. A.

George Bergstrom was a Wisconsin native who received his Bachelor of Science degree from the Massachusetts Institute of Technology in 1899. He moved to Los Angeles and had a distinguished career, being involved in the design of numerous high-profile buildings in and around the Southern California area. In 1941 and in association with partner David Witmer, Bergstrom was retained by the Secretary of War Henry L. Stimson as the chief architect for the new office building for the Department of War (now the Department of Defense).

Prior to the new office being built, headquarters for the U. S. Department of War was located in a temporary structure that had been built during World War I. The War department, at that time a civilian agency that had been created to administer the U. S. Army, was spread out over several locations in Washington, DC, as well as in Maryland and Virginia. With World War II breaking out in Europe, Stimson and many others anticipated that the U. S. would soon be drawn into the conflict. With the threat of major war imminent, congressional hearings took place and General Brehon Somervell was directed to develop a plan that would permanently house the U. S. Army's 40,000 staff members.

Nearly all government officials were in agreement that the new, all-encompassing War Department building should be constructed across the Potomac River in Arlington, Virginia. The site originally chosen was the Experimental Farm of the Department of Agriculture, several hundred acres of which were roughly pentagonal in shape. Consequently, Bergstrom produced a five-sided architectural concept that had only a few of General Somervell's requirements:

1. The building would be no more than four stories tall and would have no elevators.

2. A minimum amount of structural steel would be used to save for the war effort.

A second potential site, the obsolete Hoover Airfield, was chosen by President Roosevelt due to the possibility that the new building could obstruct the view of Washington, DC from Arlington National Cemetery, but Roosevelt chose to maintain the pentagon concept because of time constraints that would be avoided by a change in architectural design. Bergstrom completed the architectural design with the requirements by General Somervell in only five days, with the minor modification that the new building, five-sided and nearly one mile around, would now have five stories instead of four to accommodate the full U. S. Army staff and anticipated future needs. Congress authorized funding for the new War Department building in late July 1941, and President Roosevelt signed off on the estimated cost of $35 million, but which grew to nearly $63 million.

Brigadier General Hugh John Casey

The design and engineering for the new War Department building was the responsibility of Major John Casey, an aide to General Somervell in the army's Construction Division. Casey, a native of Brooklyn, had begun his engineering career at Brooklyn Polytechnic Institute before receiving an appointment to the U. S. Military Academy at West Point. Leading up to World War II he served in many functions as a leading advisor and consultant for overseas activities, including in Germany where he received civil and mechanical engineering fellowships. His services were specifically requested by Major General Douglas MacArthur in 1937 to advise the Philippine government on a large hydroelectric project, which was approved by the Philippine officials. There in the Philippines he first met Lieutenant Colonel Dwight D. Eisenhower, who was chief of staff to General MacArthur.

After being called back to Washington, DC in 1940 under General Somervell, he was instrumental in redesigning the large camps and barracks projects, enlarging the barracks to an optimum size and adding new features to improve the safety and comfort of the enlisted men. During the construction of the Pentagon, he worked with Groves and Renshaw closely, abiding by General Somervell's requirements with only a few minor exceptions.:

1. DC had a law in place that did not permit Americans of African descent to use the same restroom facilities as Americans of Caucasian lineage. Note: This law was not repealed until the late 1960's. In the meantime, try to imagine if you were one of hundreds of thousands of school kids who had come to tour Washington, DC from the Northeast or the Midwest or even many of the southern states and saw "whites only" or "coloreds only" signs everywhere in the Nation's Capital.

2. Owing in large part to this discrimination, the Pentagon designers were forced to add a fifth level.

Captain Renshaw was to be the Construction Manager, and was to report directly to Groves, who was again called upon to manage the project to its successful conclusion. The three men spent most of their time overcoming material shortages, strikes, and many other wartime priorities. By April of 1942 the Pentagon began housing officers, and by the end of May, more than one million square feet of space was available for the Army staff. Once again Groves had managed a stand-alone achievement extremely worthy of his country's gratitude, but he wasn't finished yet.

Casey went on to a brilliant military career, again being assigned to General Douglas MacArthur in the Pacific Theater. Casey was given command of engineering activities that controlled troop movements, developed new military bases, and built new airfields, including Tinian Island. Casey's efforts resulted in him being named Chief Engineer, U. S. Armed Forces Pacific. Following the surrender of the Japanese, Casey had set his sights on becoming Chief of Engineers when Lieutenant General Raymond Wheeler retired, but was passed over by President Harry S. Truman for a division engineer from Missouri, which was Truman's home state. Casey retired as a Brigadier General after thirty-one years of service, having received numerous distinguished service awards from the United States as well as several foreign countries.

A Day that Will Live in Infamy

Intelligence sources had revealed in early December of 1941 that the Japanese were amassing a large fleet of warships in the Pacific. This fact, however, did not seem to raise any alarm among the U. S. military, so the December 7th attack on Pearl Harbor was seemingly a complete surprise. Within twenty-four hours the United States naturally declared war on Japan for this unprovoked attack, and Germany followed suit by immediately declaring war on the U. S. in support of Japan, its axis partner. Suddenly America, which had been trying to remain neutral, had been drawn into two wars on two different continents simultaneously within a matter of twenty-four hours. As a result the investigation into the energy uses of uranium became a crash program on how to build what many in the military believed to be an imaginary atomic bomb before the Germans did.

Less than two weeks after war was declared, the Top Policy Committee that had been created by President Roosevelt to pursue the research and development of an atomic bomb held its first meeting. Present at that meeting were Vice President Henry A. Wallace, Secretary of War Henry L. Stimson, Vannevar Bush, Chairman of the National Defense Research Committee James B. Conant, and General George C. Marshall, Chief of Staff of the U. S. Army. Although Colonel Groves' name and reputation were discussed at that meeting, Bush remained as one of the people who was opposed to Groves simply because he was only a colonel. Dr. Bush, who was head of the president's task force to investigate the possibilities of nuclear fission and uranium enrichment had been named by Roosevelt as Director of Scientific Research and Development. Although Bush had felt all along that the development of the atomic bomb should be a civilian project, he was satisfied to some extent that the project was assigned to the U. S. Army and its Construction Division rather than to the U. S. Navy. Now that the atomic bomb project was unchained, Bush felt that it needed at least a high ranking general to guide it through the many obstacles that it would face.

B. The United States Plan

Manhattan Project Begins

Groves had been assigned to Manhattan district engineer Colonel James C. Marshall by Major General Eugene Reybold on 16 August 1942. Its headquarters were located on the 18th floor at 270 Broadway. Unlike other headquarters, however, this one had no geographic boundaries, only an ultimate goal. Thus the term Manhattan Project became the code name by the United States for the most secretive project in its history. In September of 1942 Groves' promotion to Brigadier General came through and he assumed his new command immediately. Groves, who had been seeking a military assignment in either the European or Pacific Theaters, realized that he was not a unanimous choice to head the atomic bomb project. Despite his well-deserved reputation for organization and for being a doer and a driver, he was considered by some of his peers and many of his subordinates in the United States military to be too abrasive and sarcastic at times. However, one of his main qualities was his perception in recognizing the capabilities of others Groves was always able to quickly evaluate situations and make good decisions

Despite what many in the military perceived to be some of Groves' character flaws, General Somervell had witnessed firsthand the abilities of Groves while he was still a colonel, to organize and manage projects such as the military bases and the Pentagon. Therefore, he staunchly recommended Groves for the position of leader of the Manhattan Project without any serious reservations and with no significant opposition. Groves met with Major General Wilhelm Styler, a West Point graduate and a highly regarded member of the Military Policy Committee, in the summer of 1942. At that meeting Styler requested that Groves continue as point man for the construction of the Pentagon until his promotion to Brigadier General was confirmed, and also to avoid any suspicion that Groves might be involved in what had become a top-secret project.

The day after his command began, Groves and General Marshall took a train to Tennessee and inspected property (more than 50,000 acres) that had been selected for a major plant site to produce enriched uranium (U-235). Groves took the necessary steps to purchase the property, including securing approval from the U. S. Government to create eminent domain of any private property in and around the designated area, and the land (called Oak Ridge) became the property of the Manhattan Project's first production facility.

Groves liked the Oak Ridge terrain because it was a long valley bounded by several ridges, had water and electricity supply (compliments of the TVA), and was accessible by rail and highway. The population of the settlement was initially about 3,000 when the project began, and the site was officially named the Clinton Engineer Works until four years after the war ended.

Production workers that by the end of the war numbered more than fifty thousand were housed in Oak Ridge Township homes made up mostly of quick pour concrete. Nearly fifteen hundred American workers who were of African descent were segregated into hutments and other low-cost housing accommodations at the request of Southern Democrats in Congress who did not even understand the purpose of Oak Ridge.

Once the site was selected, Lt. Colonel Kenneth Nichols was placed in charge of securing the main site and all the necessary surrounding property. The land that could not be directly purchased immediately was condemned. The short time (2 to 6 weeks) eviction notices and the inability of the U. S. Army to provide moving assistance to the more than one thousand residents in the area created particular hardships. Whenever a dispute would arise regarding improper compensation, Nichols would choose to settle the matter out of court. Similar disputes with the local governments regarding the use and maintenance of roads, bridges, and water supplies would be settled by Nichols in a similar manner so that construction on the plant could begin.

Groves Meets with Scientists across the U. S.

Within a week after his trip to Tennessee, Groves began to meet with physicists and scientists across the country. He first met with Harold Urey, a renowned professor of chemistry at Columbia University and winner of the Nobel Prize for his research with heavy water and deuterium. During this meeting Groves learned, probably for the first time, that there was more than one method for isotope separation to provide uranium enrichment. Urey and his group had developed a method using gaseous diffusion. Urey's method forced uranium hexafluoride through a membrane, forcing a separation between molecules containing U-235 and U-238. This method achieved high separations and was the first process to produce enriched uranium in useful quantities. The process actually had its beginnings in Manchester, England in 1940 as part of the British bomb-making effort, but the research work was later transferred to the U. S. as a part of the Manhattan Project.

Groves followed that up by taking a train to Chicago and meeting with Arthur Compton, a physicist and winner of the Nobel Prize in 1927 for his research in electromagnetic theory. He was a member of the president's NDRC, and had a clear vision for developing nuclear propulsion for ships and nuclear weapons using U-235 or even the recently discovered plutonium. Becoming convinced that a plutonium bomb was feasible, Compton was placed in charge of research groups at Columbia, Princeton and the University of California at Berkeley. Their primary objective was to produce reactors to convert uranium to plutonium or to chemically separate the plutonium from the uranium.

Continuing his cross-country journey by train, he met with well-known physicist Dr. Ernest Lawrence at the University of California at Berkeley. Dr. Lawrence was the inventor of the cyclotron and a recent Nobel Prize winner for his research in nuclear physics (1939). Due to his invention and influence, a huge section of the Oak Ridge Plant in Tennessee was constructed to produce isotope separation from cyclotrons (electromagnetic separation) which did produce U-235, but in small and inefficient quantities.

Methods to Achieve Nuclear Weapons

In each of these situations General Groves was able to bring these highly respected and talented scientists on board the Manhattan Project. Groves was able to convince these men that, despite the skepticism of some, this imaginary bomb could be built and their individual assistance was needed for success. The primary hypothesis that Groves garnered from his meetings with these key scientists was that there was more than one method for the production of nuclear energy.

In Groves' mind a nuclear weapon would be an explosive device of some sort in which the nucleus of an atom would collide with a particle (neutron, proton or electron) from another atom that would produce a chain reaction. While he was told that at least one of the two atoms had to be changed in the collision, there was no surety at the time for the best method to perform this task, nor was there any certainty that an explosive device of any size or quantity could even be created. Nevertheless, Groves and his team of engineers, scientists and contractors began their faith-filled pursuit of the bomb in earnest, with the primary objective being to develop this bomb before the Germans did.

Oak Ridge, Tennessee

The facilities that were developed to manufacture nuclear materials were extensive and far reaching at a time when no one really knew what materials would actually be utilized, or even how they would be implemented in an explosive device. Nevertheless, the operations at Oak Ridge began quickly, and many different programs were launched simultaneously in the hopes that at least one of them would prove to be worthwhile.

a) X-10 Graphite Plant In early February 1943 DuPont began design of the X-10 Graphite Reactor, the first continuous graphite reactor into which uranium fuel slugs could be inserted. The X-10 was meant to be the pilot plant for the Hanford Works, which would also be the responsibility of DuPont, but numerous delays resulting from an inexperienced workforce and wartime shortages of critical materials caused several months of delays. Supervised by Compton, Fermi, and Martin D. Whitaker, the reactor went critical on 04 November 1943, and the first 500 mg of plutonium was created by the end of the month. Whitaker, a North Carolina native who had graduated from Wake Forest, had a Master's from UNC and a Ph. D. in physics from NYU, became the first director of the Clinton Laboratories, which later became the Oak Ridge National Laboratories (ORNL).

When DuPont engineers decided to use bismuth-phosphate, the plant began to produce irradiated uranium slugs, and the percentage of plutonium recovered increased to 90 percent. The plant continued to produce uranium slugs until January 1945, at which time it became useful only as a research facility. A radioisotope building, a steam plant, and miscellaneous were added to the facility by the end of 1946 in order to support the laboratory's peacetime research and educational missions. It is now the site of the Oak Ridge National Laboratory.

b) Y-12 Electromagnetic Separation Plant Electromagnetic isotope separation was a process that had been developed at the University of California, using a cyclotron to deflect charged uranium particles according to mass. The process was more costly to operate and less efficient than the other processes, but it was approved because of its being a proven technology. The responsibility for this process was assigned to Stone & Webster, and the plant was started on schedule in November 1943. Within a month problems occurred with the primary electromagnetic coils, which were contaminated with rust, and General Groves ordered a temporary shutdown and cleaning of all magnet coils and process piping.

Following the cleaning of the entire system Tennessee Eastman and their female workforce were hired to operate the plant in place of the many scientists and their students who had been operating it, and the plant efficiency improved considerably. They were able to raise production to 10 percent of the U-235 feed by January 1945, and provided the first shipment to the Los Alamos Laboratory. However, once the other systems came on line, Groves ordered all primary processes and all but one secondary process to be shut down in December 1946. The plant is still used for nuclear weapons processing and materials storage.

c) K-25 Gaseous Diffusion Plant The gaseous diffusion method of isotope separation was the most promising, but it was also the most challenging. The use of uranium hexafluoride gases to separate U-235 from U-238 in a semi-continuous process was a tedious process that required vast amounts of real estate. In addition the process was extremely corrosive to all valves, piping, and pumps while producing only minute quantities of U-235. Despite its low production, the process furnished enough U-235 for the bomb that was used at Hiroshima, and was the primary process for uranium enrichment during the Cold War with the Soviet Union. The plant was ultimately dismantled, and all debris was removed by 2014.

d) S-50 Liquid Thermal Diffusion Plant This method of uranium enrichment was not originally planned for the Oak Ridge facility. However, the process had been developed at the Philadelphia Navy Yard by Philip Abelson, a University of California physicist, and showed great promise. In June 1944 General Groves contracted with the H. K. Ferguson Company to build the S-50 Plant close to the K-25 Plant in order to take advantage of the steam, water and other utilities that were being furnished to the S-50 Plant. The contractor had the plant in partial operation by September of that year, and by March 1945 it was in full production. The plant was able to enrich uranium to about 85% and joined with the K-25 plant to produce the U-235 for the bomb that was dropped at Hiroshima.

S-50 was in operation for less than one year and was shut down completely in September 1945. The buildings were used to house aircraft nuclear propulsion research for several years, but the buildings were finally torn down after President John Kennedy issued a rejection of the planned research in March 1961.

Hanford, Washington

In the meantime, Glenn Seaborg, a young chemist from the University of California at Berkeley, and his collaborators had produced Plutonium-239, a new element with 94 protons, through the bombardment of uranium. Illustrating as early as March of 1942 that plutonium was fissile, Seaborg joined the research group at the University of Chicago's Met Lab where Enrico Fermi would attempt to convert Uranium-238 to Plutonium-239. There he developed the multi-stage chemical process that separated, concentrated, and isolated plutonium. The process was further developed at the test lab at Oak ridge, and Groves had plans to build a full-scale plutonium production plant at Oak Ridge.

General Groves was very intent on having the DuPont Corporation, with their vast knowledge of chemicals and their highly regarded engineering and construction staffs build the plant. DuPont, which had been politically victimized for profiting from the manufacture of gunpowder during World I, reluctantly agreed in October 1942 to take on the manufacturing operations of the plutonium facility for a fee of one dollar. DuPont had thoroughly investigated Fermi's Met Lab concept in Chicago for plutonium production and, despite their being deeply involved in manufacturing explosives for the war effort, felt that they would have the necessary resources to build the plant at Oak Ridge. However, the DuPont project team and its technical director Crawford Greenewalt had serious concerns about placing such a large facility with potential radiation problems adjacent to other plants at Oak Ridge.

While still soliciting the necessary research scientists to join the project, General Groves dispatched his assistant Colonel Franklin Matthias to find an alternate site for the production of plutonium, one which DuPont had estimated to require about 225 square miles. Matthias and two DuPont engineers searched areas in Southern California, Oregon, and Washington. Their choice was a site along the Columbia River in Washington State that was north of Richland, WA, and encompassed more than 650 square miles. Not fully comprehending the potential hazards of radioactivity at that time, they decided to maintain a distance of at least twenty-five miles between any production facilities and the city of Richland. There would be a few displacements and some expected lawsuits, which Colonel Matthias would eventually try to settle out of court. By mid-January, 1943 General Groves officially designated the Hanford location for the proposed plutonium production.

As with many of the landowners at Oak Ridge, Tennessee, Hanford area residents rejected initial offers from the U. S. Army and took them to court, seeking more acceptable terms that would include machinery and equipment, improvements, and crop values. Colonel Matthias adopted a similar strategy of settling all claims out of court in order to save time. General Groves approved the Hanford site in late January of 1943 in anticipation that all claims and lawsuits would be resolved, and the DuPont project team began their engineering and design work immediately.

By April of 1943 DuPont's engineers had developed enough plans to begin construction of the first phase of the Fermi-Seaborg type nuclear reactor to produce plutonium. The plans were to build three piles (water-cooled nuclear reactors) at least six miles apart, and two separation plants about ten miles away and closer to Richland, WA. While a pilot plant operation at Oak Ridge which was slightly larger than the Met Lab version began in the summer, the plants at Hanford were each more than 100 times larger. That summer Hanford became the newest atomic boomtown, as thousands of workers and their families poured into the town. Many of them left in discontent and disgust as living conditions in tents and temporary barracks were extremely difficult. Gradually living conditions improved, shortages in food and other commodities were overcome, and higher pay and recreational facilities made life easier. By the end of the summer of 1944, there were nearly 20,000 workers at the Hanford Engineer Works and the population in Hanford had risen to nearly 50,000.

Crawford Greenewalt, Technical Director

Crawford Greenewalt was an MIT graduate in chemical engineering who had been steadily climbing the corporate ladder at DuPont Company for several years, as much attributable to his knowledge as to his common sense. He was assigned to be the liaison between scientists in Chicago and the engineers at Hanford Engineering Works, which was under the jurisdiction of the University of Chicago. His often contentious discussions with Fermi and Eugene Wigner, a Hungarian-born physicist, were the result of scientists in the research and experimental labs not having an understanding of what was required to design and build a many times larger working plant. Fermi, a Nobel Prize winner, couldn't seem to understand why DuPont needed so much time to be so precise in their design when all they had to do was tear down something that didn't work and rebuild it. Wigner, another Nobel Prize winner, did not approve of DuPont engineers designing the plants, feeling that he and his team of scientists could do it much better. The attitude of Greenewalt and DuPont, fortunately, was that everything had to work the first time and that there was no time to experiment in the field since the Germans were possibly ahead of the U. S. in making the bomb.

Greenewalt and the designers at DuPont did reach some compromises with the physicists at the Met Lab. They accepted Wigner's idea for reactor design and used many of his concepts for the separation plants. However, they balked at using water-cooled jackets as shielding around the reactors, fearing that any leakage in the shielding would create a radiation hazard that could not be controlled. The shielding against Beta and Gamma rays could be managed using steel or lead lining material. However, the shielding of the plutonium neutrons would escape through any metal, and using concrete for the thickness required would be prohibitive. The DuPont engineers solved the very difficult problem by using a steel-backed wood fiber board known as Masonite to shield all particles, including the neutrons.

The first irradiated slugs of plutonium were discharged from B reactor on 25 December 1944. After several weeks of storage, the slugs were moved by rail to one of the three chemical separation and concentration facilities located about ten miles away. This highly purified plutonium then underwent further purification, and the first shipment of plutonium was sent to

Los Alamos in early February, 1945. Following the war, Greenewalt served as president of the DuPont Company from 1948 to 1962, and as Chairman of the Board of DuPont from 1962 until his mandatory retirement in 1967.

Oppenheimer Selected to Manage Lab

During his trip to the University of California at Berkeley, Groves had met with several physicists and chemical scientists who he believed could be valuable assets to the project. One of those with whom he was particularly enamored was J. Robert Oppenheimer. Groves, highly intelligent and extremely effective as a manager and director, was smart enough to know what he didn't know. He was neither a scientist nor a physicist, but he felt that the right person with the type of capabilities that he lacked would be able to amalgamate the minds of the many scientific personalities that would be necessary to manifest a successful project. In late October, 1942 Groves selected Oppenheimer over the objections of some others to be the project director of the laboratory that would be required to build the bomb, and to act as liaison between the science community and the many engineers that would be required. Groves had witnessed Oppenheimer's abilities to not only understand the complex issues of atomic energy, but also to explain them in such a way that could get results. Despite not ever having won a Nobel Prize, having little administrative experience, and even being suspected of being a communist, Oppenheimer was the right person for that important role in Groves' judgment. In retrospect that decision by Groves proved to be a brilliant one.

Finding a Secret Site (Los Alamos)

Oppenheimer and Groves decided that for security and cohesion they needed a centralized, secret research laboratory in a remote location in order to develop a nuclear weapon such as the atomic bomb. Scouting for a site in late 1942, Oppenheimer was drawn to New Mexico, not far from his ranch. On November 16, 1942, Oppenheimer, Groves and others toured a prospective site in New Mexico which Oppenheimer knew well, since he had owned that ranch in New Mexico for several years. The land was a large, flat mesa near Santa Fe that was the site of a private boys' school called Los Alamos Ranch. The engineers were concerned about the singularly poor access road and the limited water supply, but otherwise felt that it was ideal. The Los Alamos Laboratory was built on the site of the school, taking over some of its buildings, while many others were erected in great haste. There Oppenheimer assembled a group of the top physicists in the United States, U. S. citizens and otherwise, which he considered to be the cream of the crop.

Although initially Los Alamos was supposed to be a military laboratory, and Oppenheimer and other researchers were supposed to be commissioned into the Army, Oppenheimer failed the Army physical test, and other researchers balked at the idea of becoming members of the U. S. Army. Groves and Oppenheimer devised a compromise whereby the laboratory was operated by the University of California under contract to the War Department. Each of the scientists and engineers that were assembled were sworn to secrecy, as were their family members. Even the president of the University of California did not know the nature of the activities at Los Alamos, surmising that a "nuclear death ray" was being produced.

Nevertheless, the objective of Groves and Oppenheimer from the very first day was to build a bomb, whether it was small enough that it could be carried by plane or so large that it had to be transported by ship. Oppenheimer initiated the recruiting process to Los Alamos in February 1943 with the war going badly on both fronts. He and Groves as well as several of the other nuclear physicists realized that if Germany was able to get the bomb first, Hitler would be virtually unstoppable. The original size of the necessary workforce at Los Alamos was greatly underestimated. Oppenheimer saw Los Alamos grow in size from a few hundred in early 1943 to more than six thousand by July of 1945.

The primary concept for the nuclear bomb, which had been decided in various conferences with scientists and engineers, was the gun-type. In this process two sub-critical masses of the purest U-235 would be brought together by firing a bullet into a specific target in order to create a nuclear chain reaction. The feasibility of a plutonium bomb had been considered. However, Wallace Akers, director of an ongoing British nuclear project, told James Conant of the NDRC that plutonium was not a practical fissionable material for nuclear weapons because of its impurities. Groves quickly convened a meeting with Conant, Oppenheimer, and other physicists, and they concluded that any problems with impurity in the plutonium could be overcome.

Although Oppenheimer and Groves gave priority to the gun-type weapon, there was some concern about its pre-detonation. Consequently, Oppenheimer created the E-5 Group at Los Alamos under the direction of Seth Neddermeyer, a Stanford graduate who received his doctorate from Caltech. The gun-type bomb design was code-named the "Thin Man", based on its long, thin shape. The implosion-type bomb was code-named "Fat Man" because it was round and almost ball-shaped. The first bomb dropped over Japan, known as "Little Boy", was a variation of the "Thin Man" design.

Kirtland Field, a large Army Air Force base on the outskirts of Albuquerque, New Mexico, became the aviation hub for the Manhattan Project at Los Alamos. Engineers and scientists at Los Alamos found the airfield, situated in the southeast quadrant of Albuquerque's urban district, to be extremely valuable to the project team, particularly in the first two years of the project. Not only was it the central base through which all necessary commodities for the war effort were transported, but it also served as a terminal to usher key personnel between Los Alamos and research centers around the U. S. Originally established as a flight training school for the USAAF, the base took on new meaning when it became a bombardier training center, and Oppenheimer and Groves had to continually remind their team that their primary objective was to build a **nuclear bomb**.

Having served as a transportation center for the needs of the people of Los Alamos, the area around Kirtland became the venue for hundreds of target sites upon which bombardiers could drop their bombs and hone their target skills. Using common runways with the Albuquerque

Airport, the facility became one of the largest civil-military airfields in the world. The majority of the training for the B-29 Super Fortress airplanes that flew out of Tinian Island on their bombing runs to Japan occurred at Kirtland. The B-29 Super Fortress that had observed the Trinity explosion had originated, of course, from Kirtland.

Dr. J. Robert Oppenheimer

Oppenheimer was born in New York City in 1904, the son of a wealthy Jewish textile importer who had emigrated from Germany sixteen years earlier. He entered Harvard College at age 18, but an illness forced him to leave school for a year. Oppenheimer spent nearly a year in New Mexico, recuperating from his illness, riding horseback, and falling in love with the Southwest. He graduated Phi Beta Kappa in 1924 with a degree in chemistry, although he had also taken courses in thermodynamics and experimental physics.

Oppenheimer studied in England for a few years before moving to Gottingen, Germany and studying theoretical physics under Max Born, where he met and made friends with such future successful scientists as Wolfgang Pauli, Enrico Fermi, and Edward Teller. There he earned his Ph. D. at age 23, supervised by Born, and published several papers on quantum mechanics and separating nuclear motion from electronic motion. The latter written in conjunction with Born is still considered to be his most cited and relevant work.

He returned to the United States and accepted a position as an associate professor at the University of California at Berkeley, working closely with Nobel Prize winning physicist Ernest O. Lawrence, providing mathematical models to explain the data that the experimental cyclotrons were producing. In May 1942, Oppenheimer was invited to join the National Defense Research Committee and to assume leadership in developing fast neutron calculations, a task that suited him perfectly. The result of his assignment was for him to host a summer school for bomb making theory at his lecture hall in Berkeley. A group of European physicists supplemented by several of his own students, many of whom went on to stellar careers as scientists, spent many hours and days calculating the requirements for making an atomic bomb.

At the time Oppenheimer's personal life was in disarray, not only because he was a chain smoker who had been sickly most of his adult life, but also because of the seeming security risk that he presented to the United States. His wife, his mistress Jean, his brother and sister-in-law, his graduate students, and many of his associates were actual card-carrying members of the Communist Party. During the entire time that he was involved with the Manhattan Project, he was under investigation by the FBI and under scrutiny by the U. S. Army. Following the success of the making of the bomb, Oppenheimer was appointed chairman of the General Advisory Committee of the newly formed Atomic Energy Commission. He lobbied vigorously for nuclear arms control, was absolutely opposed to the development of the hydrogen bomb, and supported the numerous uses for peacetime nuclear energy.

Oppenheimer was a quick study in the process of organizational division of large groups, rapidly learning the art of large-scale administration after he took up permanent residence at Los Alamos. He soon garnered the respect of his peers by mastering the many scientific aspects of the project and for his ability to control any cultural conflicts among the researchers, the engineers, and the military. Many of his cohorts leaned on Oppenheimer for his general knowledge and believed that they could trust his judgment on key matters. Oppenheimer directed many studies, theoretical and experimental, in the real sense of the words. He exhibited an uncanny speed in grasping the main points of any subject and he could acquaint himself with the essential details of every part of the work. He seemed to be intellectually, if not physically, present at each decisive step. Whether in the laboratory or in the seminar rooms, he seemed to be available when a new effect was measured or when a new idea was conceived. His main influence came from his continuous and intense presence, which produced a sense of direct participation in all of the participants and created the unique atmosphere of enthusiasm and challenge that pervaded Los Alamos throughout the project.

In the meantime, Groves and his deputy Kenneth Nichols, who had almost unlimited authority to sign contracts, hire personnel and procure necessary materials and equipment, had moved their offices to the War Department Building

C. U. S. Race to Completion

Little Boy (Gun-Type Weapon)

Since uranium-235 was the preferred fissionable isotope, its use was the first approach to bomb development pursued. The painstakingly slow process of enriching Uranium-238 to U-235 was performed primarily at the Y-12 Plant in Oak Ridge when it went on line in March 1944. Neither Oak Ridge nor Hanford were initially able to produce plutonium without impurities, meaning that the material would have a far higher spontaneous fission rate as well as higher radioactivity. While either the gun-type method or the implosion method was deemed capable by the physicists of producing the necessary nuclear reaction, the gun-type method would only be acceptable with the use of U-235.

Therefore, in July 1944 the great majority of research efforts went toward the implosion-type plutonium weapon, while the responsibility for the U-235 gun-type fission weapon was assigned to William S. Parsons, at the time a captain in the U. S. Navy's ordnance division. Parsons, a Chicago native and graduate of the U. S. Naval Academy, was trained in ordnance and had studied ballistics at the Naval Proving Ground in Dahlgren, Virginia. He became interested in radar when it was cumbersome and unpopular, which eventually led him to the development of the proximity fuze. The device, which would allow an anti-aircraft shell to explode whenever it came in proximity to an enemy plane, revolutionized the U. S. Navy in its attempts to down Japanese and German airplanes with anti-aircraft fire. The proximity fuze was so successful that by the end of 1944 these proximity fuzes were being mass produced at the rate of more than 40,000 per day.

Parsons joined the Manhattan Project at Los Alamos as Associate Director under Oppenheimer. The creation of a practical nuclear weapon would naturally require an expert in ordnance, and General Groves was really searching for an army military man with ordnance experience to assist Oppenheimer. Realizing that the individual would be dealing with scientists, Groves felt that the individual would need a great deal of coordination skills as well as a high level of ordnance planning capabilities. However, Groves knew of no one in the U. S. Army that fit that description. At that point Vannevar Bush of the Military Policy Committee recommended Captain Parsons, and it was supported by Rear Admiral William Purnell, the U. S. Navy representative on the MPC. Although Groves showed some disappointment in the selection of a navy man to the task, he later came to recognize Parsons for his outstanding achievements.

Captain Parsons, who became Rear Admiral Parsons at the end of World War II despite never having commanded a ship, proceeded to recruit some key army and mostly naval personnel to assist him with the design and construction of the bomb. The recruits included many personnel who were posted to other important assignments, but when Oppenheimer told General Groves that a particular physicist or engineer was required, Groves would apply the necessary pressure to assure that person became a member of the project team. Although there were several people that benefitted this phase of the Manhattan Project greatly, one of the most significant recruits during this period might have been Francis Birch, who was very involved in the development of the gun-type weapon which was the trigger mechanism for what came to be known as Little Boy. Little Boy was a simplified version of Thin Man, which had originally been designed to use plutonium, so it was deemed quite capable of using enriched uranium.

Albert Francis Birch

Francis Birch was born in Washington, DC and ultimately graduated Magna Cum Laude in electrical engineering from Harvard in 1924. He studied overseas for a time at the University of Strasbourg. He later returned to Harvard and studied the paramagnetic properties of mercury and copper and other geophysical pursuits. He received his Ph. D. under the supervision of Dr. Percy Bridgman, who went on to receive the Nobel Prize for Physics in 1946.

Birch was a research assistant and associate professor at Harvard through most of the depression, but took a leave of absence when war broke out and moved to MIT's Radiation Laboratory in 1942. There he met Captain Parsons and worked with him on the radar-triggered fuze that would explode in proximity to a target. The following year he accepted a commission in the U. S. Navy as a lieutenant commander, and was posted to the Bureau of Ships in Washington, DC, from where he was summoned by Captain Parsons to the Manhattan Project in Los Alamos.

When his division switched their goal from a gun-type nuclear weapon using contaminated plutonium to U-235, Birch created scale models and later full-scale mockups of the bomb using unenriched uranium. Birch actually supervised the manufacture of the Little Boy, devising the "double plug" system that would allow the arming of the bomb by the bomb commander so that the bomb would not cause a nuclear explosion in the event that the B-29 carrying the bomb were to crash. Birch would later go to Tinian Island to supervise the assembly, the loading of the Little Boy onto the B-29, and the detonation of the first atomic bomb.

The uranium loaded gun-type weapon was considered to be of a more basic design which would work only with enriched uranium. By abandoning the plutonium concept that had used the long Thin Man design, the bomb could be substantially shortened to the extent that it could now fit into a B-29 bomb bay. Little Boy's final dimensions were about ten feet in length and slightly over two feet in diameter. When the design for the bomb was completed in February 1945, Birch's team let contracts to three different companies for the necessary parts in order to maintain an air of secrecy. Its final weight was slightly under five tons, which included 141 pounds of enriched uranium. The nuclear chain reaction was initiated by small pouches of cordite, a smokeless gunpowder.

Fat Man (Implosion-Type Weapon)

The feasibility of a plutonium bomb had been explored by the physicists in late 1942, but was almost shelved when the British, who were working concurrently on a nuclear project named "Tube Alloys", concluded that plutonium might not be a fissionable material for nuclear weapons. Oppenheimer and other physicists did not necessarily agree with the British findings at that time, feeling that purified plutonium was more than a suitable material, and had finally convinced General Groves that an implosion-type nuclear weapon might be quicker to build and that any impurity problems with plutonium would be overcome.

Nevertheless Oppenheimer, fearful of pre-detonation with the gun-type weapon, established a group under Seth Neddermeyer at Los Alamos to investigate implosion. Neddermeyer, who had been working on the photoelectric proximity fuze while at the National Bureau of Standards, was recruited by Oppenheimer to provide the implosion method as a backup to the gun-type weapon. Progress was slow amid much skepticism and indifference until September of 1943, when John von Neumann joined the implosion team at Los Alamos. Von Neumann was a physicist who used mathematics in the development of functional analysis, and was one of the early developers of the digital computer. Working with Nobel Prize winner Edward Teller, he was able to create a sound mathematical model for implosion, and implosion research under Neddermeyer took a dramatic jump. Von Neumann also suggested the use of high explosives in shaped charges to explode a sphere. This fact alone resulted in a much faster assembly of fissile material than could occur with a gun method.

Oppenheimer had also recruited George Kistiakowsky, an ordnance expert who had been working with the National Defense Research Committee (NDRC) as their primary developer of new explosives. Kistiakowsky, who had fled the Ukraine as a teenager during the Russian Civil War, earned his Ph. D. from the University of Berlin in physical chemistry, emigrated to the United States, and joined the faculty at Harvard University in 1930. Leading up to and during the early war years he was involved in weapons research, and had been named technical director of the Explosives Research Laboratory before arriving in Los Alamos in October 1943. In April 1944 the first samples of plutonium that had been produced in a nuclear reactor at Hanford rather than in a cyclotron at Oak Ridge revealed five times more Plutonium-240 than Plutonium-239. This fact proved to the scientists that plutonium would be unusable unless implosion could be utilized, but only plutonium could be produced in sufficient quantities to manufacture more than one bomb every few years.

A few months later in June 1944 Kistiakowsky issued a report to Oppenheimer detailing the dysfunctionalities in the implosion team activities, thus resulting in Neddermeyer being replaced as director of the team. Oppenheimer named Kistiakowsky as the new implosion team director. Oppenheimer, possibly uncertain as to the motives of Kistiakowsky, kept Neddermeyer on as an implosion consultant. Nevertheless, the implosion method championed by Neddermeyer was used in the first nuclear test at Trinity as were the bomb dropped on Nagasaki as well as almost all subsequent nuclear weapons that were manufactured by the Unites States.

The main task of the metallurgists on the implosion team was to cast the plutonium into a sphere with a consistent density, which proved difficult because there were multiple isotopes of plutonium. Plutonium stability was a major problem and could cause pre-detonation, so several different alloys were used with the plutonium in order to create stability. The Implosion Team then discovered that a plutonium-gallium alloy could be hot-pressed into the desired spherical shape, coating the sphere with nickel to avoid corrosion. As with Little Boy, the size of the bomb was constrained to a maximum length of thirteen feet and, by removing the bomb rails of the B-29, a diameter of 66 inches was available. Drop tests using a B-29 Super-fortress began as early as March 1944, and resulted in several modifications to the bomb's structure in order to reduce wobble and provide more precise targeting.

Project Alberta

Delivery of the nuclear weapons was the responsibility of the Ordnance Division, a group that was formed by Oppenheimer in the spring of 1944 and led initially by Norman Ramsey, a noted physics professor at Harvard University. Ramsey later became a prominent member of the U. S. Atomic Energy Commission and went on to be awarded the Nobel Prize for his inventions in oscillatory field measurements. At first only the Ordnance Division was involved in the tests of various sizes of bombs, but when the tests shifted to live bombing exercises, they were moved to Wendover Army Air Field in Utah in October 1944. At that time Naval Commander Frederick Ashworth became Captain Parsons' head of operations and assumed command of the test program, while Ramsey remained in charge of delivery.

The USAAF agreed in December 1944 that any nuclear attack on Japan would have to come from the Mariana Islands. In February 1945 Ashworth traveled to Guam to inform Fleet Admiral Chester Nimitz of the Manhattan Project, and of the pending nuclear attacks on Japan. However, his view of Guam was that it had a congested harbor and a definite shortage of construction personnel. He then toured Tinian Island, which was 150 miles closer to Japan, at the suggestion of the USAAF, and agreed that their North Field was a much better location for flying nuclear weapons to Japan.

Project Alberta was formed in March 1945, basically combining the efforts of the individual groups and absorbing them into one team. Parsons became the head of Project Alberta, with Ramsey as his technical assistant and Ashworth as his military and operations advisor. Under these three men were more than fifty other Army, Navy and civilian personnel, all volunteer, who made up the Little Boy assembly team and the Fat Man assembly team. General Groves sent a construction team, made up mostly of Seabees from the 6th Naval Construction Brigade, to provide buildings for laboratory and instrument work, parts warehouses, a shop building, and assembly, ordnance, and administrative buildings. Parts for three nuclear bombs were shipped from the port in San Francisco directly to Tinian Island, and the assemblies for Little Boy, Fat Man, and Trinity were performed at Tinian.

In addition to Captain Parsons there were two senior officers on Tinian Island who were part of the Manhattan Project, although not formally part of Project Alberta; Rear Admiral William R. Purnell, representative of the Military Liaison Committee, and Brigadier General Thomas F. Farrell, General Groves' Deputy for Operations. Parsons, Purnell, and Farrell became known as the "**Tinian Joint Chiefs**", and seemed to have complete control and command over the entire nuclear mission in Japan.

Trinity Test

Oppenheimer and General Groves were both adamant in their opinion that there was the need for a full test of the implosion concept due to the bomb's very complex firing mechanism as well as the necessity to synchronize its untested explosives design. The code name Trinity was assigned to the nuclear test by Oppenheimer, inspired by the poetry of John Dunne, and the test device was informally nicknamed "The Gadget". The Trinity test was directed by Kenneth Bainbridge, a native of New York and a Harvard University professor who had graduated from MIT in electrical engineering, and who later received his PH. D. under the guidance of Karl Compton from Princeton University. The site selected was a desert area about 35 miles southeast of Socorro, New Mexico at the USAAF Alamogordo Bombing and Gunnery Range, which later became known as the White Sands Proving Grounds. The site had been inspected by auto and by air, and the only structure in the area was the MacDonald Ranch House, which had been condemned by the U. S. Army and had been vacated under protest by the MacDonald family. There the ranch house, which was about two miles southeast of the test site, was converted to a laboratory where the "Gadget" was assembled amidst dust and sand and sweltering heat in early July 1945.

A conventional explosives test had been held as a dress rehearsal on 07 May1945 in which only about 100 tons of high explosives had been detonated. A twenty-feet high wooden platform had been constructed about 800 yards from the Trinity test site. The explosion created a crater five-feet deep in the desert sand; however, a B-29 Super-fortress flown by Major Clyde Shields at an altitude of 15,000 feet could barely feel the shock, nor did the personnel at the base camp feel much shock some ten miles away.

Fears of a failed test by General Groves had led to the construction of a large steel containment vessel called "Jumbo", which would contain the plutonium bomb and allow it to be recovered in the event of a "fizzle". The vessel was ten feet in diameter and 25 feet long and had a wall thickness of fourteen inches. This was a restive moment for the physicists and engineers, who almost to a man felt that their efforts had been under-appreciated, and that their long hours and days might prove meaningless. General Groves, on the other hand, felt a personal responsibility for the billion dollar project should it prove to be a failure. While the active components of the bomb, including the plutonium core which had arrived from Tinian in a briefcase, were being assembled in the ranch house, Oppenheimer made the decision not to use "Jumbo", feeling that there were better ways to recover plutonium in the event of a dud. Instead it was hoisted up a steel tower about fifty feet in height that had been erected again about 800 yards from the Trinity test site.

Finally on 14 July 1945 the bomb was hoisted by electric winch up a 100 foot high steel tower in order to give the observers and the instruments a better indication of the bomb being dropped from a bomber, and numerous measuring devices, some as close as only 200 feet away, were put in place. The arming party, including Bainbridge and Kistiakowsky, completed arming the bomb from a platform at 10:00 PM on 15 July 1945. Precautions were taken to evacuate the civilian population if necessary, and several shelters had been built more than nine miles from the test site. Bets were taken among the physicists and scientists as to the size of the resultant explosion, from a dud all the way up to Fermi scaring the army personnel by stating that a complete incineration of the state of New Mexico was a possibility.

The detonation was planned for 4:00 AM on 16 July 1945 but was postponed because of rain and several lightning strikes in the area. A positive weather report came in at 4:45 AM, and General Groves gave the command to proceed with the detonation. The rain stopped completely several minutes later and two B-29's, one of which was flown by Major Shields, observed the test. At 5:30 AM the "Gadget" exploded with an energy equivalent of eighteen kilotons, leaving a crater in the desert five feet deep and thirty feet wide. The shock was felt over 100 miles away, and the mushroom cloud reached more than 7 1/2 miles high. Groves and Oppenheimer were obviously ecstatic, while at the same time they and most of the scientists and engineers who had observed the mighty blast, knew that this experience would change the world forever.

Potsdam Conference

Following the success of Trinity, dropping a nuclear bomb over Japan was hardly a foregone conclusion. Allied forces had defeated the Germans (V-E Day was officially 08 May 1945) and a major conference was being held in the city of Potsdam in occupied Germany to determine how the Allied Forces under Dwight D. Eisenhower and Russia under Josef Stalin would administer (and later divide) the spoils of war. In attendance at Potsdam, which began on 17 July 1945, were President Truman, Stalin, and UK Prime Minister Winston Churchill. Churchill, who saw nothing but the "devil himself" in Stalin and had urged the Allied Forces to resist Stalin's takeover of Eastern Europe, was in the process of losing the prime minister election in the UK to Clement Atlee, who wasn't convinced that Stalin was all that bad a guy. Furthermore, President Truman, who despised Stalin with a passion, had only assumed the presidency of the United States in April 1945 following the death of President Roosevelt. FDR had seen Stalin as a "kindred spirit" who would help the U. S. to democratize the world.

Japan, however, seemed far from being willing to surrender in spite of the fact that they had obviously lost most of their satellite territories and their main cities were being bombarded mercilessly by high-flying B-29 American bombers. Their atrocities against American prisoners of war had ramped up, and their kamikaze tactics against U. S. naval vessels was well documented. Although the Japanese citizenry was war weary, the Japanese military had adopted a philosophy of insanity and vowed to fight on to the last Japanese soldier. From mid-April 1945 until the Trinity explosion, the Japanese had actually inflicted more casualties on the American military than in the previous three years combined

President Truman, who had recently been made aware of the U. S. nuclear weapons program and had been told of the success at Trinity the previous day in a coded note when the Potsdam Conference began, proceeded to notify the Japanese government that they would face "...complete and utter destruction..." if they would fail to unconditionally surrender. While there was much euphoria among most of the Manhattan Project Team members and U. S. military personnel, especially General Groves and Captain Parsons, and much elation among Oppenheimer and his group at Los Alamos, there were many dissenters.

General Douglas MacArthur favored the continuation of bombing the major cities in Japan, including Tokyo which had suffered nearly fifty percent destruction, as well as several other Japanese cities which had not been victimized by any Allied bombing raids. MacArthur then planned to follow these air raids by a massive invasion which was already in the planning stages. General Eisenhower, Secretary of War Henry Stimson, and some of the scientists who had initially supported the Manhattan Project, now opposed bombing Japan with an atomic weapon on moral grounds.

However, when General MacArthur informed President Truman that there would likely be one million American casualties as a result of the invasion of Japan, President Truman issued no command and remained silent. At this point in time the United States population was about one hundred and fifty million people, and ten percent of that population had served in the military in one form or another. Of those that had served, there had already been a total of more than four hundred thousand casualties as well as hundreds of thousands of wounded; President Truman's silence on the matter made his position very clear.

Tinian Island

The target case and bomb pre-assemblies without the fissile components left a port in California on 16 July 1945 aboard the cruiser USS Indianapolis under the command of Captain Charles McVay, headed for the U. S. Army air base on Tinian Island. McVay was told that the cargo was valuable, but not what the cargo involved, and that the war would be prolonged by each day of his journey. The cargo arrived safely on Tinian Island, a small island in the Pacific east of the Philippines and approximately 1500 miles south of Japan. Again, there may have been divine intervention, because the USS Indianapolis was sunk by a Japanese submarine three days later, with only about three hundred of the ship's more than eleven hundred men surviving.

Tinian Island was chosen for the final assembly of Little Boy because it had six 8,500 feet runways and had been used for several months by long range B-29 bombers to drop conventional bombs on the major cities in Japan. In fact, one estimate was that as many as 150,000 people had been killed in the city of Tokyo alone due to the many B-29 bombing runs.

Although all of the components of "Little Boy" had been tested individually, the sub-assemblies had not been tested at Los Alamos. By this time Parsons and Birch had arrived at Tinian, and several dry runs were made out over the Pacific near Tinian to prove out different key components of the bomb. Parsons had been concerned about premature detonation of the bomb in the event of a crash, since there had been at least four B-29 runway accidents in the week that he had arrived at Tinian, so he had made the decision not to load the four cordite powder bags until the B-29 was in flight. Birch, who was most familiar with the manufacture of the bomb, had devised the system but would not be on the flight. The night before their mission, Parsons practiced for several hours inserting the powder charges and detonator into the bomb, which was now positioned in the bomb bay of the B-29 that had been chosen.

The task force at Tinian, made up of Parsons, Rear Admiral William Purnell, and Brigadier General Thomas Farrell, had decision-making authority over the nuclear mission, and had made the decision to drop "Little Boy" on Japan at the earliest opportunity. This bomb had been created using Uranium-235, which was the radioactive isotope of Uranium, and this material had never been subjected to any form of explosive tests. The 509th Composite Group, under the direction of Colonel Paul Tibbetts, had been training for several months on the dropping of inert atomic bombs and were combat-ready. In the meantime, their Bombardment Squadron had been equipped with fifteen Silver-plate B-29's which had been adapted to carry nuclear weapons. Their features included reversible pitch propellers, fuel-injected engines, pressurized cabins, and pneumatic actuators for rapid operations of bomb bay doors.

The Target Committee, comprised of General Groves and representatives from the army, army air force, and Manhattan Project, had met in April and May of 1945 and had chosen six major cities in Japan as obvious targets due to their wartime manufacturing as well as their Japanese troop concentration. Although Kyoto was on the list because of its heavy involvement in weapons manufacturing, Secretary of War Henry Stimson had removed Kyoto from the list because he had spent his honeymoon there several decades earlier, and had admired the culture and architecture of the city.

Hiroshima

On the night of 05 August 1945 "Little Boy", under the supervision of Francis Birch, was loaded into the bomb bay of the Enola Gay, a Boeing B-29 Super-Fortress. Colonel Tibbetts had some concerns as he watched "Little Boy" being loaded, since the estimated weight of the bomb was close to nine thousand pounds. He was also aware that there had been at least four accidents involving B-29's on the runways at Tinian the previous week, and he knew that he would need all of the runway with such a heavy load in order to lift off.

Shortly before the Enola Gay took off, three other B-29's had left for the shores of Japan to ascertain the weather conditions over any of the potential targets. Just before the Enola Gay took off at 2:45 a.m. on 06 August 1945, two other B-29's lifted off and accompanied the Enola Gay on its historical journey, each equipped with cameras and a variety of impact measuring devices. On board with Colonel Tibbetts was a twelve-man crew, which included co-pilot Captain Robert Lewis and tail gunner Staff Sergeant George Caron as well as Captain Parsons.

Shortly after takeoff Parsons climbed down into the bomb bay of the Enola Gay and carefully carried out the procedure that he had been practicing the night before. Flying at a high altitude in order to avoid antiaircraft fire from the ground, Tibbetts heard a signal from one of the advance aircraft about one hour ahead which indicated that cloud cover was minimal, and that they would be able to drop the bomb on the primary target. One hour later, at 8:15 a.m. (Hiroshima time) the bomb was released over Hiroshima. The blast, which missed its designed target by less than one-quarter of a mile and detonated at an altitude of about 1,800 feet, was later estimated to be the equivalent of 15 to 16 kilotons of TNT and affected an area of nearly five square miles. About two thirds of Hiroshima's buildings were either destroyed or severely damaged, but the loss of life was devastating - more than 70,000 people, including close to 20,000 military personnel, were killed, and at least another 70,000 were severely injured and later died of radiation burns. In spite of this seeming devastation of one of Japan's largest and most valuable cities for the war effort, the Japanese military command were unfazed and vowed to fight on to the death.

Nagasaki

The first plutonium core and its urchin initiator, made of polonium and beryllium, was shipped from Kirtland Army Air Field on a C-54, and arrived at North Field on Tinian on 28 July 1945. On the same day three "Fat Man" high explosives sub-assemblies were shipped to Tinian and arrived at North Field on 02 August. F31, the first of the three, was partially disassembled and its components checked out by Project Alberta personnel, then fully reassembled and wired and made ready. The second of the three sub-assemblies was used in a test drop off Tinian

Island to determine the capabilities of the B-29 Super-Fortress, while the third unit was to be assembled, presumably for a third nuclear bombing of Japan.

The Tinian "Joint Chiefs" met with General Curtis LeMay on the island of Guam on 07 August 1945, the day after the Hiroshima attack. LeMay, head of the USAAF in the Pacific, had implemented a blistering bombing attack against Japanese cities during the previous two months with high-flying B-29's and knew of all the critical targets in the country. Parsons originally stated that Project Alberta would have a "Fat Man" ready by 11 August,, but when told of pending weather conditions being too severe, agreed to have the bomb ready by 09 August.

For this mission a new B-29 Silver-plate named Bockscar, with only three combat missions to its credit, was chosen, piloted by the 393rd Bombardment Squadron Commander, Major Charles Sweeney. The "Fat Man" was wheeled out and loaded into the bomb bay, armed but with its green electrical safety plugs still engaged. Bockscar lifted off at 3:47 a.m. on the morning of 09 August 1945, with Sweeney and his crew and Commander Ashworth as the weaponeer. Ashworth changed out the electrical plugs after the plane was ten minutes in the air. During the flight an engineer noted that one fuel pump was inoperative, meaning that the fuel in that tank would have to be carried to Japan and back, consuming even more fuel. As with the flight by Enola Gay over Hiroshima, Bockscar was accompanied by another new B-29 Super-Fortress named The Great Artiste as an observation aircraft, and was piloted by Captain Frederick Bock with his crew.

The original target was the city of Kokura in the south of Japan, largely industrialized with steel mills and bomb factories. Kokura was so obscured by clouds and by the smoke of the previous day's bombing runs on the nearby city of Yawata that Sweeney, who was trying to make a visual drop, passed over it three times unsuccessfully. Fearful that he would run out of fuel and have to return to Tinian with a live bomb, he headed east toward Nagasaki. The alternate target, Nagasaki was also obscured by clouds, so Ashworth ordered Sweeney to make a radar approach.

At the last minute the crew found a hole in the clouds and "Fat Man" was dropped and, following a 43 second free fall, exploded at 11:02 a.m., Japan time, at an altitude of about 1,650 feet. In retrospect the bomb missed its intended target by almost two miles due to the heavy cloud cover and poor visibility, and damage was somewhat less extensive than at Hiroshima. However, the "Fat Man" nuclear bomb had a blast yield equivalent to 21 kilotons of TNT. More than forty percent of the city was destroyed, nearly forty thousand people, mostly civilians, were instantly killed, and another fifty to sixty thousand people were injured, many of which were later fatalities.

D. Result/Summary

Japan's Unconditional Surrender

General Groves and the Tinian "Joint Chiefs" were actually planning a third atomic bomb attack to occur on or about the 18th or 19th of August. However, President Truman had issued a request the day after the Nagasaki bombing that no further atomic bombs should be released without his express authority. This might be construed by some as Truman having had a moral awakening, but just the opposite was true. His idea as well as that of his Secretary of State and most of the military leaders of the United States, with the possible exception of General Douglas MacArthur, was to accumulate the bombs as quickly as they could be assembled and, in the still unlikely event that Japan did not surrender, begin to unleash them on a regular basis until the Japanese capitulated.

The announcement by Imperial Japan of their surrender was made on 15 August 1945, less than one week after the bombing of Nagasaki. V-J Day became official when representatives of the Empire of Japan signed the Instrument of Surrender aboard the USS Missouri on 02 September 1945. Prior to the atomic bombings the nation of Japan had taken a serious beating by the U. S. - their cities had been bombed mercilessly and their wartime military factories as well as their naval yards and shipping ports had been devastated by continual B-29 pumpkin bombs. In addition, their naval fleet and merchant fleet had been almost totally decimated. Not having the natural resources to continue, their downfall was inevitable to all but a few Imperial leaders.

However, as later depicted in some movies and newsreels, some in the Japanese military refused to surrender. Located in wide regions of the former Japanese Empire, some isolated soldiers and personnel continued to fight on for months and even several years after V-J Day.
The United States had been racing against time to develop an atomic bomb before the Germans did. Almost ironically, the Japanese became the victims of one of the most successful covert operations in U. S. history.

Atomic Energy Commission

Following the surrender of the Japanese, there was a mass exodus of "volunteer" engineers and physicists back to their respective universities and engineering companies. In addition many in the military either retired, resigned, or were reassigned. Recognizing that retaining qualified personnel would be a problem when they converted from a short-term, emergency bomb-making effort to maintaining a peacetime bomb stockpile, Groves and Oppenheimer created Sandia Base. Purchased by the U. S. Army in 1930, the old Oxnard Air Field was transformed into a top-secret ordnance design, testing and assembly laboratory for atomic weapons development.

Controversy continued to swirl around the deployment of atomic bombs and their long-term effect on humans as well as on the ecology. In the summer of 1946, after months of wrangling and opposition, a Joint Army/Navy Task Force One, headed by the Navy rather than the Manhattan Project Team, had made the decision to explode two implosion-type bombs on a fleet of obsolete and captured ships in the lagoon at Bikini Atoll. The bomb dropped from a B-29 missed its intended target, resulting in minimal damage. A second bomb was exploded 90 feet underwater, causing extensive radioactive contamination to the water. The Bikini atoll is unfit to this day for farming or fishing.

Possibly due to the Bikini fiasco or for other reasons, Congress presented the Atomic Energy Act and President Truman signed it into law on 01 August 1946. Responsibility for nuclear weapons and nuclear energy was transferred from the U. S. Army's Manhattan District Corps of Engineers to the U. S. Atomic Energy Commission on 01 January 1947. David Lilienthal, a lawyer and career politician, was appointed as its first chairman. The AEC inherited total control of all Manhattan Project facilities, including Oak Ridge, Hanford, and Los Alamos. A joint (U. S. Army & Navy) task force created the Armed Forces Special Weapons Project with General Groves named as its director the following month.

The AEC initially played a key role in investigating the environmental effects as well as the potential prospects for nuclear energy with government as well as with the private sector. As the AEC developed and implemented its regulations, critics from all areas of the atomic spectrum began to voice their opposition and offer differing viewpoints. The design of nuclear reactors was either too rigid, or else it did not offer enough safeguards. Protection of the environment was either ignored, or else it was too costly. Finally, the AEC was abolished in 1974, their regulatory functions were transferred to the Nuclear Regulatory Commission, and it was eventually rolled into the all-encompassing Department of Energy.

Prologue: General Leslie Richard Groves

General Dwight D. Eisenhower, now Chief of Staff of the United States Army, met with General Groves on 30 January 1948 to give Groves a performance evaluation. Eisenhower cited a long list of grievances about Groves, pertaining to his arrogance, contempt for the protocol of the U. S. Army, and his seeming to maneuver for promotion out of turn. Eisenhower made the point very clear that Groves would not be promoted to any significant post while he was in command. What was left unsaid by Eisenhower was his strong dislike for General Douglas MacArthur, who had top command in the Pacific Theater, and his resentment that Groves' use of the atomic bomb was actually the method by which MacArthur had defeated the Japanese and won the war in the Pacific.

Groves wasted little time following his meeting with Eisenhower, beginning his retirement from the U. S. Army on 29 August 1948. Groves went on to have a successful business career, retiring from the Sperry Rand Corporation as vice president after thirteen years with that company. He wrote an account of the Manhattan Project that was published the year after his retirement from Sperry Rand. General Groves died in 1970 from a heart attack at age 74 and is buried in Arlington National Cemetery.

Prologue: Dr. J. Robert Oppenheimer

Robert Oppenheimer's attitude regarding the creation of the atomic bomb changed dramatically over a period of just a few months. Whereas he was euphoric about his accomplishments and those of his project team after Trinity and even Hiroshima, he was appalled by the bombing and carnage at Nagasaki. By October of 1945 he had told both Secretary of War Henry Stimson and President Truman that he did not feel that the second bomb on Japan was a military necessity, and that he wished to see all nuclear weapons banned in the future.

Once the Atomic Energy Commission (AEC) came into being in 1947, Oppenheimer was appointed Chairman of the General Advisory Committee. In this role he emphasized basic nuclear science and arms control, being one of the major opponents to the United States pursuing the hydrogen bomb, fearful of getting into a nuclear race with Russia. However, once the Russians conducted their first atomic bomb test in 1949, Oppenheimer realized that the race was on. Nevertheless, his opposition to creating more and larger nuclear weapons had angered many people in the political arena, and he became the subject of an FBI probe into his alleged communist background.

In spite of his tremendous wartime efforts in developing the bomb that helped bring World War II to an end, his security clearance was revoked in 1953, and he was later severely castigated during one of the well-known McCarthy hearings. In 1954 he was banned from further government involvement because of his being a potential security risk, despite the fact that General Groves and many of his associates testified on his behalf. Oppenheimer continued to lecture, receiving many tributes and awards in his later life. He was politically exonerated in 1963 when President John F. Kennedy presented Oppenheimer with the Enrico Fermi Award. Oppenheimer, a heavy smoker, was diagnosed not surprisingly with throat cancer in late 1965, underwent throat surgery and numerous radiation and chemotherapy treatments during 1966, and finally succumbed to the deadly disease in February, 1967. Although rarely mentioned and seldom considered as the "Father of the Atomic Bomb", Dr. Julius Robert Oppenheimer was certainly its "Chief Architect."