Leslie R. Groves:
The General Responsible for the World's First Atomic Bomb

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As World War II raged, Albert Einstein wrote a letter to Franklin D. Roosevelt in October 1939, which contained a dangerous warning: Nazi Germany was likely to have begun developing a nuclear bomb.[1] The letter galvanized the US into action, and the government assembled the best nuclear researchers and scientists in the world at the Chicago Metallurgical Laboratory (Met Lab) in early 1940.[2] The scientists, including Robert Oppenheimer, Enrico Fermi, and Leo Szilard, were responsible for groundbreaking discoveries and research of nuclear fission, when a radioactive atom splits into lighter elements releasing a powerful burst of energy. However, while their knowledge and discoveries were critical for the scientific foundation of the bomb, discovery itself was not enough for a weapon of this scale. Scientists were ill-equipped to develop revolutionary industrial processes, obtain vast amounts of the rarest raw materials on earth, build complex machinery, and conduct a project that required the mobilization of the US army and the industrial giants of the US. In realizing this challenge, the government introduced military leadership of the nuclear bomb project, officially naming it the Manhattan Engineer District (MED). In September of 1942, the Secretary of War Henry L. Stimson appointed General Leslie R. Groves as the Commanding General to assume sole control of the Manhattan Project.[3] Though he is remarkably obscured in history, it was Groves who transformed the previous academic conference into discreet, industrial pieces to enable the fastest possible development of the bomb. <u>Groves's wartime construction expertise, far-reaching administrative power, and strictly compartmentalized style of leadership allowed him to manage the unprecedented obstacles of developing the revolutionary nuclear technology of the Manhattan Project, as he was ultimately responsible for the industrialized, efficient, yet highly secure, approach required to win the atomic race against Germany.</u>

In early 1942, before Groves's command, the Manhattan Project was under the military leadership of General George C. Marshall; however, he and the other military leaders lacked the commitment and leadership ability to advance the effort. As a temporary Commanding General, Marshall continued to operate the development research efforts at a small scale.[4] When recommending that Col. Wilhelm Delph Styer, executive officer for the chief of the Construction Branch, would be the best for leading the project after him, Marshall explained that Styer's position would only be "part time." [5] As a leader, he failed to grasp the years of painstaking and fully-committed work required to accomplish a project of such complexity. The assigned priority rating given by Roosevelt's new War Production Board, which determined the accessibility of raw materials and funding, also fell below the level needed. The most urgent construction programs received ratings of AA-1 through AA-4, in decreasing order of superiority, with the highest AAA rating reserved for temporary emergencies.[6] Marshall met with Brig. Gen. Lucius D. Clay, Army Service Forces deputy chief of staff, on June 30 to request an AA rating. Because the Army Navy Munition Board was limiting the number of AA-1 and AA-2 ratings, Clay provided a disappointing AA-3 rating.[7] Marshall weakly gave in to Clay, feeling that the promise of an AAA rating in times of emergency would be sufficient.[8] With the increasing probability that the Germans were engaging in fission research and the British report on July 15, 1941 which revealed that the "release of atomic energy on a large scale is possible" and weaponizable, the accomplishments of the project under Marshall up to late 1942 proved to be highly inadequate.[9] Once the advisors realized the years of committed effort the MED would require, they eliminated Marshall and everyone else whose other commitments would not permit them to provide full focus on the project.[10] At this time, General Groves, basically in charge of all army construction in the United States, attracted Styer's attention as he had demonstrated unmatched intelligence and efficiency in his leadership of the largest construction programs of the US, including the nearly completed Pentagon.[11]

Through his military project experiences in the decade leading up to the Manhattan Project, Groves had built up a set of skills and gained vital knowledge, turning him into a highly capable and effective leader of large military construction programs. First, he learned how to operate large, military construction programs under complete secrecy. In charge of procurement in the Supply Section of the Military Division of OCE in the early 1930s, he oversaw the LOCATOR program which was responsible for developing antiaircraft detectors.[12] He started one of the first large, secret contracts that was ever issued by the War Department, pioneering the development of heat detection aircraft locators.[13] A critical learning experience for Groves, he coordinated contractors, engineers, and scientists simultaneously in complete secrecy. Second, he learned how to control the largest military programs of the nation by adopting innovative methods of operation during the WWII mobilization period. By February 1941, Groves was appointed as chief of the Operations Branch of the Quartermaster Construction Division.[14] Among Groves's most important responsibility as chief was to create a government-owned, contractor-operated (GOCO) munitions industry, building and designing a massive range of plants that produced military weaponry.[15] By early 1942, Groves's daily challenges and responsibilities had reached incredible heights. He successfully oversaw a million men at work and a monthly value of $730 million ($14 billion 2001 dollars), larger than the total value of military projects from 1920-1938.[16] To complete his massive projects, including the construction of the Pentagon, he adopted innovative methods, such as the master design and procurement contract, where a contracted company would oversee, design, and provide services for a selection of projects.[17] Third, and through the master design and procurement, he developed close relationships with the largest industrial companies of the US, most importantly E. I. Du Pont de Nemours (Du Pont) which he would call upon later during the Manhattan Project.[18] Fourth, Groves also gained vast knowledge of working with raw materials while operating munitions plants, as Groves and his engineers were in constant pursuit of steel, lead, rubber, tin, chromium, vanadium, copper, hemp, zinc, iron, cadmium, nickel, aluminum, magnesium, mercury, and sisal, to name a partial list, which were always in short supply.[19] Finally, Groves gained experience with Army-Navy Munitions Board priority classifications, as many of Groves's projects had an AA rating due to their demand of raw materials.[20] In his massive swath of power, Groves had assumed the responsibility for all construction operations of the Army and built over 8 billion dollars of completed work. In the process, he proved that he rarely leaned on superiors while making decisions and was singly capable of completing his projects' goals by any means necessary.[21] As a result, Styer recommended Groves to Stimson as the best choice in the nation to lead the Manhattan Project.[22]

Immediately after taking control of the Manhattan Project, Groves proved Styer's recommendation, accomplishing more in a week than Marshal had in months by attaining the highest priority rating possible. Groves, a champion of the Army Corps of Engineers, was uncompromising in his demand for raw materials, and as a high ranking and powerful military officer, he had the influence to get what he wanted.[23] His recent construction experience had led him to correctly believe that a low priority rating of AA-3 would be the single greatest obstacle in obtaining the rare, raw materials for the bomb.[24] In sharp contrast to Marshall and Colonel Kenneth D. Nichols' failed, timid method, Groves marched into Donald Nelson's office, chairman of the War Production Board, declaring the current rating was unacceptable.[25] With the slim chance of the project even succeeding, Groves demanded complete authorization and access to all possible resources to get the job done.[26] When Nelson refused, Groves abruptly ended the conversation and, before leaving the room, threatened that he would have to recommend "to the Secretary of War that the Project be abandoned on the grounds that Mr. Nelson refuses to carry out the wishes of the President."[27] Upon leaving his office, Groves had attained signed papers granting a permanent AAA priority rating, forcing Nelson to be "in full accord with the prompt delegation of power by the Army and Navy Munitions Board through [Groves]." [28]

In the same first week, Groves set up a powerful internal organization capable of making fast, effective decisions, and made key purchases to set up the project's industrial expansion. On September 23, Stimson had proposed a committee of able men from the military to lead the project along with Groves and suggested that it should contain seven to nine members.[29] Groves vigorously objected explaining it would be too large and ineffective, as he believed large staffs too often were conducive to inaction and delay and hindered "the leaders' capability to make prompt and intelligent decisions."[30] Despite the massive size the project would grow to, Groves instead set up a "simple and direct" internal organization that "enabled [him] to make fast, positive decisions."[31] The small group of capable leaders, each subordinate to Groves who was alone at the very top of the pyramid of power, would characterize the future years of Manhattan Project leadership.[32] Next, using the newly obtained AAA priority rating and his powerful internal organization, Groves sent orders to purchase massive amounts of rare Belgian uranium ore, and shortly after, issued the paperwork to purchase the Oak Ridge site, a plant that produced fissionable uranium and plutonium.[33] In these early stages, the project was based on vast amounts of scientific theory and very little proven knowledge, which concerned Groves as an engineer. He explained that "even if the theories were correct, the engineering difficulties would be unprecedented." [34] In the face of the obstacles the scientists and engineers would soon face, Groves, in the first week of leadership, created the foundation necessary to transform the project into a massive, industrialized construction project.

From the early academic focus of the MED, Groves transformed the project into a gigantic industrial-engineering effort, drawing from his vast construction knowledge from previous projects and using unorthodox industrial methods to produce uranium and plutonium, the two most important materials of the atomic bombs. Since the beginning of the military takeover of the project, the traditional scientific methods of the researchers clashed with Groves's industrial leadership.[35] The small-scale laboratory methods of the scientists appalled Groves from the moment he assumed authority of the project. He explained how "[the scientists] were simply not accustomed to moving with courage and rapidity," and that "none of them were go-getters: they preferred to move at a pipe-smoking academic pace."[36] According to Robert S. Norris, a historian who attributes the success of the MED to Groves, the common historical emphasis of science and the work of leading physicists and chemists such as Robert Oppenheimer underplay the organizational and physical construction aspects of the project, which were essential in dealing with the uncertain technologies of the projects, intense wartime pressure, and the true industrial scale of the bomb.[37] Despite the necessity of their scientific contribution, the scientists consistently demonstrated that they were oblivious to the larger challenge of the real-world application of their theoretical science, forcing Groves to alter the course of the project significantly.[38]

During his previous experience with the Holston Ordnance Works (HOW) project, Groves learned a crucial industrial method of developing products when having access to limited research. The HOW was a large, top-secret munitions plant that produced RDX, a type of high tech explosive, for WWII.[39] Groves was involved in the HOW just before the Manhattan

Project.[40] Though smaller than the Manhattan project, the HOW was nevertheless massive as it covered over 6500 acres of land, erected 242 buildings, built 31 miles of railroad, 141 magazines, and 59 miles of roads, cost a total of $128.7 million, and produced 434,000 tons of RDX.[41] Like all military-science projects of such a scale, Groves and other leaders faced endless problems. To name a few, there was a pressing shortage of design information for the complex technology in the explosives, shortage of expensive equipment required to build the explosives, and a weak War Production Board priority rating.[42] Given the enormous scale of the project yet lack of concrete knowledge, the HOW was virtually designed, built, and operated simultaneously, as there was little to no time to plan the project before beginning operation, nor enough information to begin with to conduct pilot programs.[43] Groves's success in operating the factory plants of the MED stemmed from his ability to apply the HOW model when lacking the information for traditional production methods.

Groves applied the construction expertise he gained from the HOW to the separation process of fissionable uranium-235 (U-235), eventually producing a sufficient amount of the metal for a test bomb and the Hiroshima bomb. The fission bomb relies on a relatively large amount of U-235, a rare yet highly fissionable isotope of uranium. However, natural samples of uranium primarily contain three isotopes: about 99.3% of U-238, 0.7% of U-235, and 0.006% of U-234.[44] The separation of U-235 from the more abundant U-238 was one of the most difficult, yet important efforts of the Manhattan Project.[45] Scientists had narrowed down the separation into three theoretical processes: the electromagnetic process, the gaseous diffusion process, and the thermal diffusion process.[46] Even for the most promising electromagnetic method of separation, the technological obstacles initially made the process seem impossible for large-scale production. According to Groves, electromagnetic separation required "extremely complicated, and as yet undesigned and undeveloped, devices involving high vacuums, high voltages and intense magnetic fields."[47] Dr. George T. Felbeck, in charge of the gaseous diffusion process, explained that the processes "[were] like trying to find needles in a haystack while wearing boxing gloves."[48] Additionally, vast amounts of physical and chemical research, and research in allied fields including medicine, metallurgy, and biology, would be required before beginning effective production.[49] Despite these challenges and lack of research, Groves daringly drove forward the electromagnetic process on a full-scale effort using the HOW model.[50] He abandoned the idea of intermediate development or a pilot plant, which would take years of unavailable time, and he designed, built, and operated the electromagnetic factory and the complex nuclear reactors simultaneously. Despite the continuous and inevitable design and technological issues, Groves supplied extremely decisive leadership to overcome complications, just as he had with the HOW project, to produce U-235 in the quickest way possible.

Before the Manhattan Project, Groves also encountered another innovative and highly effective industrial procedure, the critical path method (CPM), that would help him achieve the rapid building of the Hanford site, another major plant that produced the plutonium for the Nagasaki bomb. CPM is a detailed and organized way of laying out every step of a particular project to study the most effective routes towards a specific goal.[51] On each step of the way, every member working on the project would be prescribed a specific role contributing to the route as a whole, with their next steps laid out on a detailed schedule.[52] Groves had encountered CPM when building munitions plants during the mobilization period, as it was utilized largely by Du Pont.[53] Although the term CPM had yet to be coined, Du Pont, for the first time, used the program of critical path and pioneered a revolution in the architect-engineering-construction industry.[54] Groves pushed the engineers to utilize CPM at Hanford, in turn resulting in the incredibly rapid construction of the plant.[55] Groves was directly responsible for implementing the practices that allowed for the timely production of uranium and plutonium, the two most critical materials of the Hiroshima and Nagasaki bombs.

As Groves continued to expand the Manhattan Project, he merged the scientific processes with the engineering expertise of American industrial giants. Through his deep knowledge of corporations, he recruited the best-suited companies to drive forward the industrialization of Met Lab and the Hanford plant. The most influential of these companies was in fact Du Pont, a personal choice of Groves as he believed it was uniquely qualified for the MED.[56] Du Pont was founded as a gunpowder manufacturer in 1802 and had evolved into an unconventional, self-reliant industrial company.[57] Groves developed a deep understanding of Du Pont and its competitors during the mobilization period as he had signed many of the contracts that the company worked on. [58] Unlike its competitors, Du Pont designed, constructed, and operated its plants in-house instead of working with subcontractors, which was important to Groves as it allowed for its rapid, yet effective work.[59] Its relative self-reliance suggested effective security, research competence, and industrial accountability.[60] Franklin Matthias, a civil engineer who directed the construction of Hanford under Groves, recounted that Groves had directed him to review the work of Du Pont and their reports "because [the company] was so far ahead of any of the other builders in the country."[61] As a result of the company's demonstrated capability, Groves sought Du Pont to impart its own expertise in the challenge of producing plutonium.[62] However, once Groves pitched his idea to Du Pont, the company hesitated at the serious responsibilities they would need to fulfill running the entire plutonium project of the MED.

Du Pont strongly opposed taking on the plutonium job due to the daunting challenges it posed; however, through his persistence, Groves convinced the board that their role would be of utmost importance and eased their fears of the difficult task that lay ahead of them. Not two weeks after Groves had been in control of the MED, Groves approached Du Pont to take over the design and development of a plutonium semi-works at the Oak Ridge plant.[63] Du Pont had no experience in nuclear physics, as the company specialized in industrial chemistry, and were rightfully skeptical of the project's feasibility.[64] Because there was such little definitive research on plutonium production, Groves was asking them to sign a highly risky contract. Once Groves briefed Du Pont president Walter S. Carpenter about the MED role, Carpenter explained how he believed that "[they] were asked to take on a job about equivalent to perpetual motion," as "recovering the power of an atom" seemed to be "beyond all conceivable reach."[65] However, Carpenter explained how Groves would simply not take no for an answer, as Groves persistently urged the board to consider the importance of the project.[66] Throughout his meetings with the Du Pont executive committee, Groves explained three basic military considerations regarding the MED's importance:

> First, the Axis powers could very easily soon be in the position to produce either plutonium or U-235, or both. There was no evidence to indicate that they were not striving to do so, therefore we had to assume that they were. To have concluded otherwise would have been foolhardy. Second, there was no known defense against the military use of nuclear weapons except the fear of their counteremployment. Third, if we were successful in time, we would shorten the war and thus save tens of thousands of American casualties.[67]

Though there was a lack of enthusiasm within the company, the overwhelming importance of their role in the project and the war overshadowed the concerns, and the company took on the job.[68] Groves personally believed that it was for these three reasons that he was able to convince the executive committee to take the job.[69]

Despite causing a scientist-engineering cultural clash, Du Pont imparted their industrial expertise to quickly build the world's first full-scale plutonium reactor at Hanford, solving for safety hazards and fundamental inaccuracies in the Met Lab designs. Before Du Pont entered the project, the Met Lab scientists had already built small cubic piles that successfully multiplied the radioactivity of an artificial source of neutrons. Anticipating further success, Met Lab designed scaled-up versions of the reactors, hoping to achieve a fully self-sustaining reaction before the year's end.[70] These first plutonium-producing reactors, however, suffered from critical instances of engineering naïveté (according to a later assessment from Du Pont's senior manager Crawford Greenwalt).[71] The reactors featured a batch method, requiring several weeks of non-operation every month for plutonium extraction and radioactivity dissipation. Met Lab's method of extraction was also extremely hazardous, releasing dangerous clouds of radioactive dust. [72] Most importantly, the reactors needed to be a thousand times more powerful in order to produce the necessary amount of plutonium for the bomb.[73] Further research on plutonium production called for dramatic increases in its production scale, requiring engineering expertise beyond that of the Met Lab scientists.[74] Groves instructed Du Pont managers to assess the procedures of plutonium manufacturing at the laboratory, with the purpose of evaluating, refining, and optimizing the scientists' reactors according to viable industrial processes.[75] Groves and the Army Corps of Engineers assigned significantly more authority to Du Pont than to Met Lab, as they were anxious to see a transition from laboratory research to industrial engineering.[76] By February 1943, Du Pont was firmly in command.[77] High-ranking Met Lab scientists constantly criticized Du Pont and the military were "slow and cautious," largely due to the scientists' lack of large-scale engineering experience and bitterness in being subordinate to Du Pont. In reality, Du Pont moved with incredible speed, building the first full-scale plutonium production reactor (the X-10 reactor) at Hanford in just over a year.[78] Equipped with new technologies, cooling systems a hundred times more effective than the Met Lab model, and featuring continuous operation instead of the batch method, the massive X-10 reactors achieved a truly industrial scale. Proving Groves's intuition in assigning full authority to Du Pont, the company's emphasis on overengineering and industrial safety measures transformed the faulty, hazardous, and inefficient reactors of Met Lab.

As industrialization expanded the project to a nationwide scale, MED counterintelligence prevented critical information from being leaked, except for a few espionage cases, due to an intelligence revolution largely centered around Groves. He advanced a security operation of compartmentalization to unseen levels while successfully maintaining project productivity. Generally, weapons projects require secrecy, especially those under pressure and of a large scale, to ensure the success of its defensive or offensive purpose. The existence of a weapons project is one of the most important secrets, as the primary danger is the enemy building and deploying the weapon first.[79] In fact, once the word of the German bomb effort was leaked, the US increased its efforts significantly and invested billions of dollars to build the bomb first.[80] Additionally, if the enemy caught wind of the project, sabotage attempts could delay progress or halt the effort altogether. Lastly, the enemy would have time to brace for an attack if they discovered they were being targeted.[81] The Manhattan Project demanded effective security, as it had reached a nationwide scale and had become crucial to winning the war.

During the stages of unstructured, scientific leadership before Groves's arrival in late 1942, the leading scientists failed to realize the importance of a centralized security system, making vital information easily accessible and revealing the urgent need to revamp security protocols. Even though the scientists in charge had little experience in running weapons construction programs, they still understood the importance of secrecy.[82] From the moment fission and the possibility of the atomic bomb was discovered, physicists introduced secrecy into their own work to prevent others from attempting to use their developments to build a nuclear bomb.[83] By 1940, physicist Gregory Breit, a strong advocate for restrictions on the scientific knowledge among scientists, began to propose formal measures of security. He introduced the cubical system, the first instance of compartmentalization, in which each team of workers or scientists knew only what they needed to know to complete a specific task, limiting the amount of collaboration between scientists.[84] To the scientists, their voluntary restraint made formal security measures seem unnecessary, and as a result, Breit's efforts at centralizing security failed.[85] In his letter of resignation, he outlined the primary security violations which included meeting among different "compartments," the common "loose talk" of information, and the unauthorized appropriation of classified documents.[86] In response to chemist James B. Conant's worries, who was another security conscious scientist, Colonel John Lansdale and the War Department carried out an undercover assessment of the Berkeley Lab. Lansdale revealed to Conant that physicists and chemists explained to him the U-235 separation process without hesitation, and that he could have stolen the blueprints of the cyclotron if he had wanted to.[87] Once returning to Washington, he exposed the critical security state at Berkley and revealed the desperate need to revamp the security system.[88]

As Groves took over the project, he pushed the internal security of the project to unprecedented levels by pioneering a new system of compartmentalization, serving as the backbone of the MED security operation. In consulting with engineer Vannevar Bush, Groves found that the underlying problem was the risks associated with the unrestricted exchange of information among the various scientists, engineers, and other personnel, which significantly increased the likelihood of vital secrets being leaked.[89] Immediately, Groves became hyper-focused on developing the security of the project. As he wrote in his book *Now it can be Told*, he directly established strict control over free-flowing information: "Compartmentalization of knowledge, to me, was the very heart of security. My rule was simple and not capable of misinterpretation - each man should know everything he needed to know to do his job and nothing else."[90] The system was incredibly effective in limiting the knowledge of workers, as the majority only had a fragmentary knowledge of the purpose, scale, and timeline of the project. Despite the hundreds of thousands employed in the MED, compartmentalization resulted in only a few senior-level officials knowing the full picture of the atomic bomb, and less than a thousand knowing that atoms were involved.[91] In constructing and choosing the different sites of the project, Groves additionally ensured the different facilities were physically compartmentalized and isolated from each other, despite causing communication and operational challenges. Because each site had its own specific purpose and was oblivious to the activities of the others, enemy espionage or a nuclear accident at one site could not jeopardize the entire project.[92] At the Los Alamos site, however, Groves faced continuous scientific opposition from leading scientists like Oppenheimer who argued that compartmentalization would be counterproductive by restricting the scientific method.[93] Groves permitted the free flow of ideas and compromised by securing the site through other physical methods. Unsurprisingly, the Los Alamos site was home to the most significant cases of Soviet espionage throughout the entire MED, proving the effectiveness of Groves's security consciousness.[94] In all other cases, MED reached an unprecedented level of security that protected vital information without trading off the project's efficiency.

Contrary to Oppenheimer's and other scientists' beliefs, Groves further utilized compartmentalization to dramatically boost the efficiency of the project as it allowed him to gain absolute control over every aspect of the project. According to Norris, "[compartmentalization] was the secret to Groves's power."[95] Through compartmentalization, Groves created a pyramid of power. At the uppermost level, there were about a dozen officials who knew nearly everything. Groves ensured this small number of leaders, who were focused on other aspects like waging war and diplomatic, political, and military activities, were not overwhelmed by the specifics of the bomb program. [96] As a result, every last detail of building the bomb was left to Groves, omniscient and alone at the very top of the pyramid (Appendix A).[97] All aspects of the project, whether it was the construction of sites, research, the building of the bomb, the separation process, production, or the operation of factories were all wired through Groves.[98] Compartmentalization ensured that every worker was concentrated on his specific task only, as Groves explained:

> Adherence to [compartmentalization] not only provided an adequate measure of security, but it greatly impacted overall efficiency by making our people stick to their knitting. And it made quite clear to all concerned that the project existed to produce a specific end product-not to enable individuals to satisfy their curiosity and to increase their scientific knowledge.[99]

The independent purpose of each worker, site, and projects within the overall MED was only successful because Groves effectively orchestrated each component through his authoritative power. For example, Groves leveraged the physical compartmentalization of sites and each site's lack of knowledge of the others to stimulate competition between them. As physicist Norman Ramsey observed, "generally General Groves would deliberately give Los Alamos excessively optimistic reports as to what was being done at Oak Ridge" and vice-versa, so that "in this fashion he could make both groups really work hard, since each group would think it was a bottleneck and therefore things would get done faster."[100] Groves's authoritative methods of leadership were only successful because of his independence, as Styer previously outlined that "he was accustomed to operating with as little supervision as possible" and did not "lean on superiors for decisions."[101] According to Carpenter, Groves consistently "[made a number of decisions on very important matters of course involving huge sums of money] without hesitation" and with "great courage and ability." His decisiveness and courage were crucial because compartmentalization required endless high-pressured decisions. He was demanding and critical, and as the Army Corps of Engineers puts it, "as unsparing of himself as he was with others."[102] Only because of Groves's merciless control, independence, and decisiveness was the strict compartmentalization successful in increasing the productivity of the Manhattan Project.

Ultimately, Groves applied his vast administrative authority to galvanize the project's urgent momentum. His priorities as MED Commanding General were to speed up progress, make people work harder and longer, overcome obstructions, and most importantly, build the bomb as fast as possible. Leveraging his influence as a high-ranking military officer, he recruited the best industrial firms of the nation, putting together a diverse group of engineering, architectural, and construction firms that collaborated on the same industrial enterprise. He optimized research, construction, and production by using his extensive prior experience and integrating industrial processes with nuclear science. He made crucial decisions quickly and effectively, that according to Norris, "had they been the wrong ones, would have resulted in failure or delay."[103] His judgment of which industrial firms to select, which small group of subordinates to trust, which methods of U-235 separation to follow, and countless other decisions were sound and successful. The fact that Groves consistently made effective choices while having incredibly little information and hard research to consult speaks to his keen instincts and masterful judgment. He ran the project in a specific way, unique to only him and no one else. Given his commanding position at the center of all MED operations, Groves was singularly the most influential figure of the project. He alone was the one irreplaceable component in the success of the Manhattan Project.

It was not until 2002, however, when Norris was the first historian to fully expose the Groves's influence on the Manhattan Project's with his book *Racing for the Bomb*. Even today, the mainstream perception of the Manhattan Project remains incomplete. Historians have rightfully turned the project into a dramatic and riveting story, as the stakes were huge, the groundbreaking scientific discoveries shocking, the moral issues it raised subject to decades of debate, and its legacy profound. Remarkably, Groves is left out of this story except for brief mentions of him taking charge in 1942, or him building the Pentagon. Until Norris, the majority of historians omitted one key detail: Groves was integral to the success of the project. Many historians continue to view him as a fringe character subordinate to the scientists and their great discoveries. What they focus on is the scientists' criticism of Groves's character. Colonel Nichols describes Groves as "most demanding," "abrasive and sarcastic," and "the most egotistical man" he knew.[104] Relative to the scientists, Groves had not done anything seemingly new. Rather, he did everything better than anyone else ever had, pioneering revolutions in intelligence, organization and management, and weapons industrialization. Though the more interesting fission discoveries underplay Groves's role in the Manhattan Project, he solely belongs at the center of the military colossus that built the world's first nuclear bomb. Despite his harsh description of Groves's character, Nichols most tellingly ends his quote by saying, "…if I had to do my part of the atomic bomb project over again and had the privilege of picking my boss, I would pick General Groves."[105]

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[19] Norris, *Racing for the Bomb*, 152.
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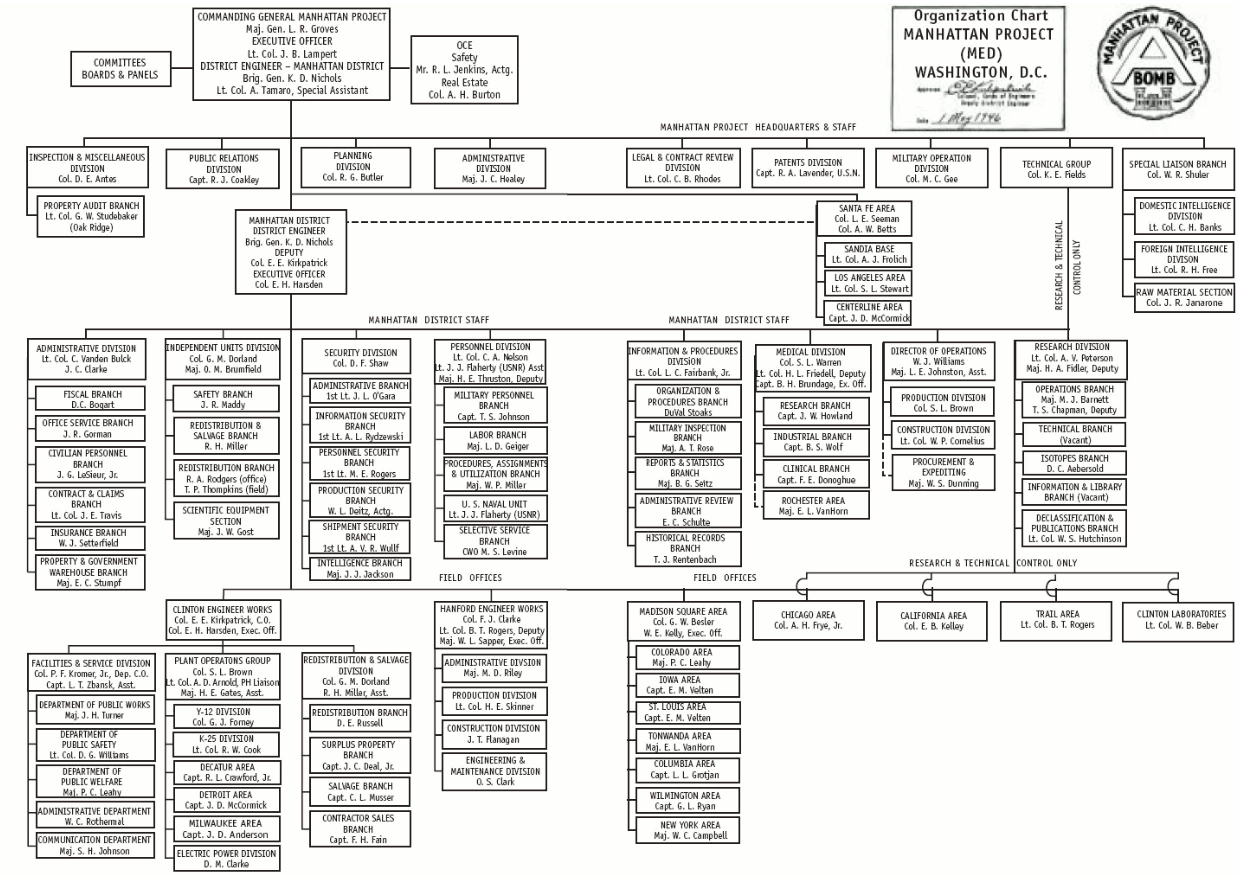
APPENDIX

Appendix A: The MED Organization Chart. A depiction of General Groves in control of every aspect of the project. *Source: US Army - Defense's Nuclear Agency, "Manhattan Project Organization Chart," chart, May 1, 1946, digital file.*



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