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Racing for the Bomb: General Leslie Groves, the Manhattan Project'sIndispensable Man

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political dimensions of technological innovation. He is blissfully ignorant of a decade of writing about the process of military-technical innovation in the twentieth century. The book has no compelling theme or interpretive core. Although this reviewer usually grimaces when graduate students invoke such deities as Thomas S. Kuhn and Michel Foucault, this book would have benefited from more theoretical structure.

Terrors and Marvels might also have profited from more attention to innovations that did not involve the gallant struggles of Nobel laureates in physics and chemistry to convince know-nothing politicians and generals to adopt their latest schemes to win the war. Storytelling conquers all. From the perspective of military logisticians and commanders, innovations in food processing, materials research, automotive engineering, computer technology, synthetics, and chemical explosives were war winners too. Schachtman gives them all short shrift. His discussion on preventive medicine and the treatment of combat trauma wounds is particularly limited, given the rich multi-volume official histories of the U.S. armed forces medical establishments in World War II.

Part of Schachtman's difficulty is that he really does not know much about World War II, apparently alternating carelessly between the books of Martin Gilbert and Richard Overy—who, of course, are blameless for his series of gaffes. A few samples should suffice: Ishii Shiro's final rank was lieutenant general, not major (p. 318); Iwo Jima was prized as a fighter base and emergency landing site, not a B-29 base (p. 298); Japanese troops did not land on Bataan in December 1941, and they did not seize "American garrisons at Shanghai and Tientsin," since the 4th Marines and 15th Infantry had already departed (p. 166); the 17 August 1943 Eighth Air Force raid on "Schweinefurt" [*sic*] was made by 230 B-17s, not 376, and German flak accounted for only six bombers from the 1st Bombardment Wing, which lost thirty B-17s to German fighters. In fact, the entire first paragraph of chapter 7 is riddled with fiction. The sparse account of Allied military medicine ignores a central fact and accomplishment—wounded survival rates were important but not as important as the number of American wounded who returned to a duty status of some sort. The number of wounded combatants who lived to fight another day is dramatized in the story of Company E, 506th Parachute Infantry Regiment, immortalized in word and videotape by historian Stephen Ambrose. Another slip is Shachtman's sketchy account of the role of operations research and analysis mathematics; it ignores a massive literature on operations research in air warfare, logistics, and antisubmarine warfare—a literature that Shachtman apparently does not know.

In sum, a single volume on the influence of scientific and technological innovation on World War II would be welcome. *Terrors and Marvels* is not that book.

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Norris, Robert S. *Racing for the Bomb: General Leslie Groves, the Manhattan Project's Indispensable Man.* South Royalton, Vt.: Steerforth Press, 2002. 722pp. $40

Today, when a major weapons system commonly takes decades or more to develop, it is hard to imagine that the greatest weapon system of them all, the Manhattan Project, took just three years from start to detonation over Japan. Those three years were the stuff of high technical and engineering drama: vast new industrial facilities were constructed in secret across the United States, two billion dollars were spent without congressional oversight, new scientific laboratories were secluded in the high desert, and a unique U.S. Army Air Forces B-29 unit was created. All this took place under the direct command of Major General Leslie Groves, U.S. Army Corps of Engineers, whose management style set a norm for large systems-development programs that persists today.

In the popular recollection of the Manhattan Project, the physicists Robert Oppenheimer, Enrico Fermi, Leo Szilard, Edward Teller, and the Los Alamos Laboratory dominate. They are attractive figures who have remained in the public eye. Yet Groves, never a popular or sympathetic personality, was the man who put it all together. As such, he is worthy of serious attention.

Robert Norris, research associate with the Natural Resources Defense Council and scholar of nuclear issues, has written a long-overdue biography of General Groves. While the central theme of this work is Groves's leadership of the Manhattan Project, Norris does a thorough job of integrating into the story his formative years, family, Army career prior to the project, and postwar role in establishing a national policy for atomic weapons.

The sheer audacity and scope of the Manhattan Project remain impressive today. Based on theory and some critical experiments at the University of Chicago in the late 1930s and bolstered by a letter from Albert Einstein to President Franklin Roosevelt, the United States in 1942 committed itself to building an atomic bomb.

Groves, who had had a distinguished career as an Army engineer and had been the overseer of the building of the Pentagon, was selected to head the Manhattan Project in August 1942. Within just a few months, Groves brought together some of the best engineering officers in the Army, initiated vast land acquisitions for several large industrial operations for the purpose of isotope separation, established the basic technical compartmentalization policies that shaped the entire project, and brought into the program a number of prominent industrial corporations to build and run the plants. As the project grew, Groves fought for and won the highest priority for critical materials within the government's wartime allocation scheme, cornered the world market for uranium ore, set up the Los Alamos Laboratory, and appointed Oppenheimer as director.

Groves was a technically shrewd and aggressive man with complete confidence in his own judgment and willingness to take enormous technical and industrial risks with untried processes. His most remarkable talent was the ability to oversee and pursue alternative technical development lines until one or another was proven successful. In two important cases he made such high-risk decisions—isotope separation and bomb design.

Separation of uranium isotopes on an industrial scale was a critical step in the bomb manufacture. At the time, there seemed to be three competing methods: gaseous diffusion, thermal separation, and electromagnetic separation. Each method had its advocates and its virtues. None was proven. While the scientific community dithered over the best technical method, Groves charged in and, with real managerial brass, initiated simultaneous and parallel development of all three separation methods, making the largest bet on the gaseous-diffusion method at Oak Ridge.

As the engineering worked out, using the partially enriched product from the thermal and the electromagnetic separation processes as feedstock for gaseous diffusion gave accelerated results, and the enriched uranium was ready on time for the bomb.

Initially, there were two quite different design approaches to building the bomb. The most obvious was the gun assembly technique, in which two subcritical masses of enriched uranium were explosively driven and held together until nuclear fission began and was sustained. This design became the "Little Boy" bomb that was dropped on Hiroshima in the world's first atomic attack.

However, theory held that the use of plutonium would produce a far more efficient means of nuclear detonation. Plutonium is an artificial element, bred in a uranium-fueled reactor that is formed into a hollow sphere and implosively crushed with high explosives until a nuclear detonation occurs. This proved to be a demanding technical problem requiring massive industrial sites for plutonium production at Hanford, Washington, and nearly all the talent at Los Alamos to calculate and form the sphere and the surrounding high explosives.

Again, Groves made the call, and both avenues were followed, at great cost, until the TRINITY test at Alamogordo, New Mexico, proved the plutonium implosion, which was used in the "Fat Man" bomb dropped on Nagasaki.

Since Hiroshima and Nagasaki, historians have devoted nearly as much energy to debating who made the decision to use the bomb as was released in the atomic explosions. Norris goes into this in some detail, looking specifically at Groves's role in decision making. He concludes that, as is commonly the case with large weapons development projects in wartime, the momentum of the project drove the outcome. The bomb was ready, an invasion of Japan looked to be murderously costly, momentum carried the day, and the bomb was dropped on Japan.

Norris's book is a fine complement to Richard Rhodes's *The Making of the Atomic Bomb* (1986), in which Rhodes covers the physics of the bomb. Both books chronicle events that changed the world.

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Wright, Patrick. *Tank: The Progress of a Monstrous War Machine.* New York: Viking Penguin, 2002. 499pp. $29.95

The tank constitutes perhaps the most readily identifiable symbol of land warfare. From its initial appearance during World War I to the final stage of the Gulf War, its considerable impact on the outcome of some of last century's most significant wars is not in doubt. Whether battles were fought on the plains of Eastern Europe or in the deserts