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PART II

The World War II Manhattan Project: precedent for beam-weapons development

by Richard Freeman

Last week, we published Part I of "The World War II Mobilization That Ended the Depression." Below is the second and concluding part, the story of how the Manhattan Project achieved in three years what many at the time said would require three to four decades.

In 1939, the development of controlled nuclear reactions was much, much further from realization than laser-based weapons are today. Many thought it could not be done. Ernest Rutherford, the "lion" of British science in the 1930s, dismissed the idea of harnessing the power of the atom as "the merest moonbeam."

Americans and others took a different view. In December 1938, two physicists at the University of Berlin, Otto Hahn and Fritz Stassmann, conducted experiments proving that atoms of the radioactive element uranium would split when bombarded with neutrons. A few weeks later, French Nobel Prize winner Frédéric Joliot-Curie showed that the uranium atom, once split, released more than one neutron, and that a chain reaction was indeed possible.

In 1939, in the United States, Enrico Fermi, a refugee from Mussolini's fascism, and Leo Szilard confirmed Joliot-Curie's experiment at their physics laboratory in Columbia University. Szilard wrote of the night of their dramatic breakthrough:

"Everyone was ready. All we had to do was to turn a switch, lean back and watch the screen of a television tube. If flashes of light appeared on the screen it would mean that large-scale liberation of atomic energy was just around the corner. We just turned the switch and saw the flashes."

President Franklin Roosevelt had created the Uranium Committee in 1939 to study the prospects of an atom bomb. But for the first years of the war, the committee just spun its wheels. In 1940, F.D.R. placed the Uranium Committee under the National Defense Research Committee.

But the tenor of work on the atom bomb was to change dramatically in September 1942, when the President appointed Col. Leslie Groves of the U.S. Army Corps of Engineers to be the engineering overlord for the Manhattan Project. The Army Corps was established in the 19th century to build dams, canals, and other infrastructure projects. Groves had actually worked on a plan to build a second Panama Canal through Nicaragua. The President had been receiving reports of German efforts to develop the A-bomb, and his instructions to Groves were simple: at whatever the cost, make sure the United States develops the bomb.

This would have to be a crash effort.

As reported by Peter Pringle and James Spigelman, there were four efforts underway, which Groves reviewed, to produce a controlled nuclear reaction:

1) "At Columbia University, Harold Urey, whose discovery of heavy water had won him a Nobel Prize, was in charge of a technique called gaseous diffusion. This required passing uranium gas, including U-238 and U-235, through a series of porous barriers. Since the lighter U-235 isotope passes through the pores more easily than the heavier U-238, the end result would be a gas 'enriched' in U-235." U-235 was the fuel for the nuclear reaction.

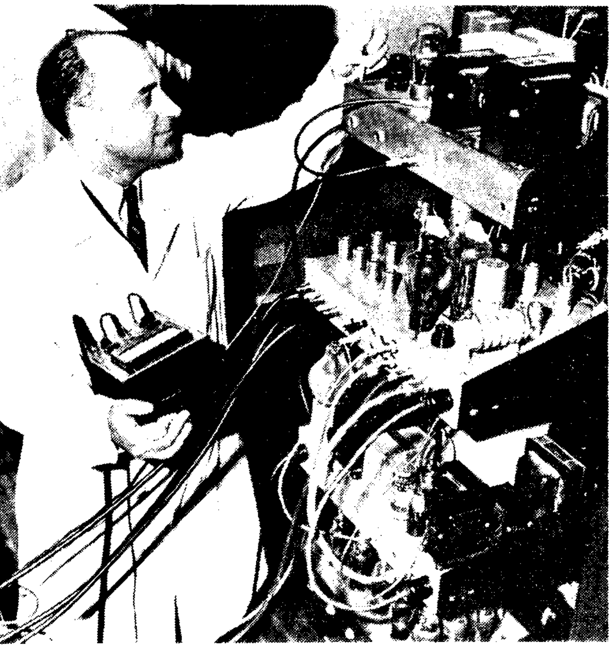
2) "At the University of California, Ernest Lawrence—the inventor of the cyclotron, or atom smasher, and himself a Nobel laureate—headed the group working on the electromagnetic process for separating U-235. This involved passing uranium gas over a large magnet. The lighter particles of U-235 would be attracted to the magnet at a different rate than the heavier U-238.

3) "In Pittsburgh, Eger Murphee, a Standard Oil of New Jersey engineer, was supervising a project to separate U-235 using a centrifuge. In this method, the lighter U-235 is parted from the heavier U-238 by putting uranium gas into a large rapidly spinning machine and driving off the heavier isotope—a method akin to separating cream from milk.

4) "Finally, at the University of Chicago, Arthur Compton, who had won the 1927 Nobel Prize in physics for his studies of x-rays, was in charge of building what was shortly to be the world's first working nuclear reactor. It would soon produce minute quantities of plutonium."

The United States deliberately funded duplication of efforts: each project, with the exception of the third, was pushed ahead. This parallel approach guaranteed the greatest rate of discoveries, since it could not be predicted in advance which method would work first. At the same time, within the bounds that security precautions allowed, the teams working on a project could cross-fertilize their ideas. This parallel effort and cross-fertilization of ideas characterized the Manhattan Project effort.

Colonel (later General) Groves drove the effort forward


Courtesy of the Niels Bohr Library, University of Chicago

Enrico Fermi

at a frantic pace, a pace at which many in the Project bridled, but which all concerned admitted the Project could not have been completed without. The projects required vast engineering skills. The magnets that Ernest Lawrence wanted to construct for his cyclotron were huge machines, using thousands of tons of steel, and were bigger than any previous U.S. lab machines. Huge quantities of graphite, in a degree of purity never before envisaged, were required. So with uranium metal, previously handled in grams. Groves needed tons of everything.

A story is told of Groves one day paying a visit to the U.S. Treasury Department. He needed thousands of tons of silver for industrial and scientific purposes. An effete Treasury official when told of Groves's requests for silver sniffed, "Around here we talk only of troy ounces."

What Groves accomplished in two-and-a-half years might have taken three to five decades in normal peacetime conditions. For example, to build the first nuclear plant, he had to build the first fully automated factory, the first plant completely operated by remote control, the first totally leakproof industrial system—six million square feet of machinery that had to be kept as spotless as an operating room.

In the process of making the Manhattan Project work, Groves whipped his subordinates at an incredible pace, and tested the country's recently developed organizational skills and technical talents. Two entirely new cities were built—Oak Ridge, Tenn. and Hanford, Wash.—each within less than a year. At Hanford, a small village on the banks of the Columbia River, an army of 25,000 construction workers, with 11,000 pieces of major construction equipment, excavated 25 million cubic yards of earth and laid 158 miles of railway track and 286 miles of road. A similiar process was repeated along the Clinch River between the Great Smoky and Cumberland mountains in Tennessee, creating the city of Oak Ridge.

It was the work at the University of Chicago that produced the first breakthrough. The physicist Enrico Fermi had been brought there to work with Arthur Compton and a team of other top scientists. There the reactor pile consisted of 40,000 graphite blocks arranged in a circle; inside it were 50 tons of uranium in oxide form. Into the uranium were inserted neutron-absorbing rods that, when withdrawn, allowed the neutrons to start their atom bombardment leading to a chain reaction. On Dec. 2, 1942, under Italian physicist Fermi's direction, this pile produced the first continuous chain reaction. The code words called down to Washington, D.C. after this exciting event were, "Jim, you'll be interested to know that the Italian navigator has just landed in the New World. He arrived sooner than he expected."

Work proceeded. Finally on July 16, 1945 at the Journado del Muerto testing facilities in New Mexico, the first atomic bomb was exploded. The method used was to detonate plutonium by a process known as implosion. Previously, scientists had found that because the critical mass of plutonium—uranium-238 enriched by one neutron—was too unstable, it was impossible to bring the plutonium together without getting a premature reaction. In the implosion process, the outside of two hemispheres of plutonium, together weighing less than the critical mass, are coated with an explosive. On detonation, the plutonium is squashed inward, forming a mass that, although subcritical in actual weight, becomes critical because of the huge pressures on it from the explosion. The timing of the detonation is crucial. All the explosives must detonate a precisely the same moment.

At 5:30 a.m. on the morning of July 16, Groves and others in observation dugouts six miles away from the plutonium bomb witnessed a remarkable sight. At that moment the sky exploded with light, a fireball arose, and the surrounding desert sand turned into glass because of the heat. The harnessing of the fission power of the atom had been achieved, an outstanding achievement for all of mankind.

The hideously wrong decision to drop the atom bomb on Hiroshima and Nagasake is another matter that won't be explored here, except to say that the darling of today's peace movement, the bloodthirsty scientist Robert Oppenheimer, was the one who pushed President Truman to drop the bomb on the Japanese cities; and the supposed warmonger, the scientist and present supporter of directed energy beam defense systems, Edward Teller, opposed the dropping of the A-bomb for humanitarian reasons.

A footnote is necessary: The development of the cheap, efficient, and safe use of nuclear power would not have occurred had the military not intervened a second time. It was Admiral Hyman Rickover, foreseeing correctly the need of nuclear submarines to travel long distances underwater without surfacing, who pushed the use of nuclear fuel. Because of him primarily, the logjam of developing nuclear power plants to produce electricity was broken.