Science and Conscience: Chicago's Met Lab and the Manhattan Project
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Exhibition Text

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INTRO PANEL TEXT

SCIENCE AND CONSCIENCE: CHICAGO'S MET LAB AND THE MANHATTAN PROJECT

On December 2, 1942, scientists at the University of Chicago produced the world's first self-sustaining nuclear chain reaction beneath the West Stand of Stagg Field, the University's athletic stadium. This experiment, crucial to the control of nuclear fission, drove a rapid nationwide expansion of the Manhattan Project, the secret federal research and engineering program charged with producing a nuclear bomb.

Chicago's role in the Manhattan Project did not end with the successful operation the first nuclear reactor. Buildings across the University of Chicago campus were converted for use by the code-named Metallurgical Laboratory. The Met Lab conducted extended research on the structure of uranium, developed the process for separating plutonium from uranium, and investigated nuclear radiation's biological effects and safety issues. At the end of World War II, the Metallurgical Laboratory was transformed into the first United States federal laboratory, Argonne National Laboratory.

Chicago's Met Lab also took the lead in organizing scientists' political response to the devastation caused by atomic bombs at Hiroshima and Nagasaki. Concerned about the future development and use of nuclear weapons, Met Lab veterans created the Atomic Scientists of Chicago and began publishing the *Bulletin of the Atomic Scientists*. They joined scientists from other Manhattan Project sites across the country and pressed successfully in 1946 for the passage of the Atomic Energy Act (McMahon Act) and creation of the civilian Atomic Energy Commission.

The Met Lab scientists achieved great technical success in their contribution to the creation of a powerful new military weapon. Yet the sobering consequences of their work moved them to enter the political arena and make the first critical arguments to control nuclear weapons and turn nuclear energy toward peaceful ends.

CASE TEXTS

SECTION ONE: ATOMIC RESEARCH - BEFORE THE PILE

Rome, Stockholm, New York

In 1938, Enrico Fermi was a 37-year-old professor of physics at the University of Rome. His reputation had grown substantially with studies of atomic particles and his work in theoretical and experimental physics. On November 10, his achievements received their greatest

recognition when Fermi learned he had been awarded the Nobel Prize in Physics. The official announcement cited Fermi "for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons."
The Nobel Prize was a signal professional honor. But living in Mussolini's Italy with his Jewish wife, Laura, Fermi had become increasingly concerned about the growing number of Fascist anti-Semitic laws and the government control that might be imposed on his scientific research. In December 1938, Enrico Fermi left Italy with his wife and two children to accept the Nobel Prize in Physics at the award ceremony in Stockholm. Instead of returning home to Rome, however, the Fermi family traveled to England and then on to New York City, arriving in January 2, 1939. Fermi immediately took up a professorship that he had accepted at Columbia University and began working intensively with a young colleague there, Herbert L. Anderson.

Fission

In late December 1938, as the Fermis were on their way from Stockholm to New York, German scientists Otto Hahn, Lise Meitner, and Fritz Strassman discovered nuclear fission. Physicist Niels Bohr brought the momentous news to the United States a few weeks later, announcing the successful splitting of the uranium atom on January 26, 1939, during the Fifth Washington Conference on Theoretical Physics at George Washington University. Two days later, Fermi, Bohr, and other colleagues witnessed a recreation of the fission experiment at the Carnegie Institution in Washington. Word of the discovery spread rapidly, spurring new experimental work at Columbia, Princeton, Berkeley, Chicago, and other university laboratories.

Columbia University

Working at Columbia University from 1939 to 1942, Enrico Fermi and Herbert Anderson furthered their collaborative research on fission, constructing a series of exponential piles to test their theories. Fermi concluded that it should be possible to sustain a chain reaction in uranium which, under the right conditions, might multiply fast enough to cause a nuclear explosion. Along with physicist Leo Szilard, Fermi proposed placing the uranium in a matrix of graphite, forming a cubical lattice with potential for inducing a self-sustaining controlled reaction.

SECTION TWO: ANDO CASE

Manhattan Project and Met Lab

Amid fears that German scientists might already be well on their way to creating a chain reaction, President Franklin D. Roosevelt in the fall of 1941 approved a full-scale effort to apply atomic theory to the design and construction of a new military weapon. Arthur Holly Compton, Nobel laureate and professor of physics at the University of Chicago, was placed in charge of the program, which was named the Manhattan Project. Compton and colleagues decided that the work of building and operating a test reactor would be concentrated in Chicago under the code name Metallurgical Laboratory (Met Lab).

Early in 1942 Enrico Fermi and groups of scientists began to arrive at Chicago, where they collaborated on refinements in the design of a nuclear pile. After plans to build the reactor at a remote site on the outskirts of Chicago were blocked by a labor strike, construction shifted quickly to a space beneath the West Stand of Stagg Field on the University of Chicago campus. Originally designed for racquetball, the room had been in use more recently as a squash court.

Constructing CP-1

In November 1942, in the squash court beneath the West Stand of Stagg Field, construction began on a nuclear reactor that was designated Chicago Pile-1 (CP-1). Layers of graphite blocks containing slugs of uranium metal and uranium oxide alternated with layers of solid graphite blocks, gradually forming a roughly spherical shape supported by a wooden framework. A specially ordered cubical balloon-cloth bag encased the reactor to reduce absorption of neutrons by nitrogen in the air. Higher grades of uranium became available as work progressed, allowing the pile to be redesigned in a somewhat reduced size with a flattened top.

Chain Reaction

Construction on CP-1 halted at the fifty-seventh layer on December 1, 1942, when measurements indicated the pile would become self-sustaining once the control rods were withdrawn. On Wednesday, December 2, Fermi and his colleagues gathered on the balcony of the West Stand squash court to complete their test of the reactor. After tests in the morning and a break for lunch, the last control rod was slowly withdrawn until the "critical," or self-sustaining, level was reached. The scientists then watched the reactor operate for twenty-eight minutes before reinserting the rod and stopping the reaction. CP-1, the world's first nuclear reactor, was an operational success. Arthur H. Compton telephoned Harvard University president James B. Conant, a member of the Manhattan Project Military Policy Committee, to convey the news: "The Italian navigator has just landed in the New World."

CP-1 and CP-2

Following the successful chain reaction experiment on December 2, 1942, Met Lab scientists continued further experiments on the CP-1 reactor. At the end of February 1943, CP-1 was dismantled so that the materials forming the reactor could be moved to Site A, a secure location in Cook County's Argonne Forest Preserve twenty miles southwest of Chicago. There the reactor was reconstructed in a more cubical form, with a larger quantity of uranium and increased concrete shielding against radiation.

Renamed CP-2, the new reactor began operation in March 1943 and became the focus of important experimental work by Enrico Fermi, Herbert Anderson, Leona Woods Marshall, and other Met Lab scientists who commuted from Hyde Park to Site A on a regular basis. On the University of Chicago campus, the space beneath West Stand of Stagg Field was reconfigured and transformed into a modern laboratory for Met Lab work.

Managing the Met Lab

The rapid increase in the scale of the Manhattan Project in 1943 brought a wave of additional scientists and lab staff to the University of Chicago campus. At its peak, the Met Lab at the University of Chicago employed more than 2,000 workers; by the end of World War II, more than 1,300 were still on the payroll.

The administrative structure of the Met Lab consisted of numerous divisions: Theoretical Physics, Experimental Nuclear Physics, Chemistry, Biology, Mass Spectroscopy, Medical, Health Physics, and Patents, among others. Divisions were further subdivided into sections and groups. Some Met Lab workers were recruited from the greater Chicago area, but others drawn to the project from elsewhere in the country. Many of those who found employment in the laboratories and offices were women.

The growing space needs of the Met Lab required appropriation of all or part of many University of Chicago campus buildings. Eckhart, Jones, Kent, and Ryerson halls were all called into service, as were the North Stand and West Stand of Stagg Field. A sprawling structure known as the New Chemistry Building and Annex was erected along Ingleside Avenue from 56th to 57th Street, while south of the Midway Plaisance a former brewery company building owned by the University was expanded and outfitted as a laboratory known as Site B. Some Met Lab facilities were also located in non-University buildings in the immediate neighborhood, at the Museum of Science and Industry in Jackson Park and at the 124th Field Artillery Armory on Cottage Grove Avenue.

University Facilities Occupied by the Met Lab

Anatomy Building
Billings Hospital
Drexel House
Eckhart Hall
Ellis Laboratory
Jones Laboratory
Kent Laboratory
New Chemistry Building and Annex
Ryerson Hall
Service Building
Site B
Stagg Field, North Stand
Stagg Field, West Stand

Awards

As World War II came to a close, scientists and administrators associated with the Metallurgical Laboratory received certificates of appreciation for their service to the nation. Some like Enrico Fermi and University of Chicago President Robert Hutchins were acknowledged in formal ceremonies. Other Met Lab workers employed within the U.S. Army's Manhattan Engineer District, the official name of the Manhattan Project, were presented a smaller but no less

distinctive award: an A-Bomb pin, bronze for those serving less than a year, silver for those with more than a year's service.

Quotes displayed on case wall

[1]
Graphite and uranium, radium and beryllium sources, Geiger counters and other instruments – everything was packed and shipped to the Metallurgical Laboratory. And Enrico went to settle in Chicago.
Laura Capon Fermi
Atoms in the Family

[2]
The best place Compton had been able to find for work on the pile was a squash court under the West Stands of Stagg Field, the University of Chicago stadium. President Hutchins had banned football from the Chicago campus, and Stagg Field was used for odd purposes. To the west, on Ellis Avenue, the stadium is closed by a tall gray-stone structure in the guise of a medieval castle. Through a heavy portal is the entrance to the space beneath the West Stands. The squash court was part of this space. It was 30 feet wide, twice as long, and over 26 feet high.

Laura Capon Fermi
Atoms in the Family

[3]
The squash court ceiling could not be pushed up as the physicists would have liked. They had calculated that their final pile ought to chain-react somewhat before it reached the ceiling. But not much margin was left, and calculations are never to be trusted entirely. Some impurities might go unnoticed, some unforeseen factor might upset theory.

Laura Capon Fermi
Atoms in the Family

[4]
We found out how coal miners feel…After eight hours of machining graphite…one shower would remove only the surface graphite dust. About a half-hour after the first shower the dust in the pores of your skin would start oozing...Graphite is a dry lubricant…and the cement floor covered with graphite dust was slippery.

Albert Wattenberg
"The First Pile," 1946
Manhattan Engineer District

[5]

Szilard was still quite concerned. He said that the night before the first test, which was December 2, 1942, the evening of December 1, 1942, he went out and he had a second dinner. He told the person who he ate with the second time that night why he was having a second dinner. Szilard, who was always a voracious eater said, “We have an experiment that we’re going to run tomorrow. Chances are it won’t work at all, but there’s a remote chance it will work too well. And if it works too well, that’s why I’m having a second dinner tonight.”

William Lanouette
Oral history interview
Atomic Heritage Foundation

[6]
We entered the balcony at one end of the room. On the balcony, a dozen scientists were watching the instruments and handling the controls. Across the room was a large cubical pile of graphite and uranium blocks, in which we hoped the atomic chain reaction would develop. Inserted into openings in this pile of blocks were control and safety rods. After a few preliminary tests, Fermi gave the order to withdraw the control rod another foot. We knew that that was going to be the real test.

Arthur Holly Compton
Oral history interview
Argonne National Laboratory

[7]
Fermi, of course, gave the instructions. He made the calculations, which were not really very elaborate, but had to be done correctly at the time. He got information to make his calculations from recorders. He also got measurements from Leona Woods. A station had some counting equipment, which was in another part of the room.

Walter Zinn
Oral history interview
Argonne National Laboratory

[8]
Then somewhat later, after the control rods were all put to bed and the charts were pulled out and clipped up and so on, Eugene Wigner showed up with a famous little flask of Chianti. He poured it into paper cups. We went and drank it very quietly. There was no toast, nothing, no remarks. Nothing very dramatic, really: The most effective kind of drama probably at that point.

Leona Woods Libby
Oral history interview
Argonne National Laboratory

[9]

[On the evening of December 2, 1942] I gave a large party for the metallurgists who worked with Enrico and for their wives. As the first bell rang shortly after eight in the evening, Enrico went to open the door, and I kept a few steps behind him in the hall. Walter Zinn and his wife Jean walked in, bringing along the icy-cold air that clung to their clothes….Walter extended his hand to Enrico and said: "Congratulations."

"Congratulations?" I asked, puzzled, "What for?"

Before we had time to sit down, the bell rang again; again Enrico went to open the door, and amid complaints about the extraordinary cold weather I again head a man's voice: "Congratulations."

It went on this same way until all our guests had arrived. Every single man congratulated Enrico. He accepted the congratulations readily, with no embarrassment or show of modesty, with no words, but with a steady grin on his face.

I went up to Leona Woods…"Leona, be kind. Tell me what Enrico did to earn these congratulations." Leona bent her head, covered with short, deep-black hair, toward me, and from her lips came a whisper: "He has sunk a Japanese admiral."

Laura Capon Fermi
Atoms in the Family

SECTION THREE

Los Alamos and Trinity

As the Manhattan Project expanded and diversified, scientists with needed expertise were moved from one site to another. In addition to working in Chicago, Enrico Fermi spent extended periods at the huge plant in Hanford, Washington, developing and testing the first large plutonium production reactor. By the summer of 1944, he and his family had been transferred to Los Alamos, New Mexico, where he became part of the bomb design and fabrication effort headed by J. Robert Oppenheimer.

In the early morning of July 16, 1945, at the Trinity Site 35 miles outside Socorro, New Mexico, scientists from Los Alamos successfully detonated the world's first atomic bomb, a plutonium implosion device nicknamed the Gadget. Along with Oppenheimer and Manhattan Project head General Leslie Groves, Enrico Fermi witnessed the explosion and mushroom cloud from a control bunker situated 10,000 yards away. Also on site that morning was physicist Samuel K. Allison, who had headed the Met Lab in Chicago during 1943-1944 before going to Los Alamos. Allison held responsibility for reading off the final countdown for the Trinity bomb detonation.

Hiroshima and Nagasaki

Scientists at Chicago's Met Lab were among the earliest to express apprehension about their work on nuclear weapons. By the summer of 1943, Chicago staff members were voicing their concerns in private or at meetings with military security guards present. At one of these gatherings, James Franck, a German Jewish refugee and professor of chemistry at the University of Chicago, spoke movingly from his own experience of the danger of governmental control over science.

Throughout 1944, expressions of concern came with increasing frequency and clarity. In June of 1945, Met Lab scientists organized committees to transmit their views to Washington. James Franck chaired the Committee on Social and Political Implications that urged the atomic bomb be demonstrated to Japanese leaders first in an uninhabited place rather than dropped without warning, arguing that "if the United States were to be the first to release this new means of indiscriminate destruction upon mankind, she would sacrifice public support throughout the world, precipitate the race for armaments, and prejudice the possibility of reaching an international agreement on the future of such weapons."

Despite appeals from the Franck committee and others, President Harry S. Truman authorized the immediate use of atomic weapons against Japan without any prior demonstration. On August 6, 1945, a uranium-based atomic bomb was dropped on the city of Hiroshima, causing massive damage. Three days later, a plutonium implosion bomb was dropped on the city of Nagasaki, again with significant destruction. Estimates of the cumulative death toll in both cities, ranging from 130,000 to 240,000, were difficult to calculate with any precision. Thousands of victims who were not killed immediately suffered the effects of injuries and radiation sickness leading to debilitation and death in the months and years that followed.

Atomic Scientists' Movement

On August 7, 1945, the day after the bombing of Hiroshima, Met Lab scientists met under the leadership of Eugene Rabinowitch to draft a statement arguing for civilian administration of atomic research, international controls, and programs to educate the public about atomic weapons and nuclear energy. By mid-September, the group had constituted itself as the Atomic Scientists of Chicago.

John A. Simpson, chair of the ASC executive committee, joined William Higinbotham of the Los Alamos scientists' group in coordinating political efforts to promote effective legislation in Washington. Public education initiatives included *The Atomic Bomb* and other publications as well as advertising campaigns. An ASC speakers' bureau was organized to dispatch scientists to address schools, churches and synagogues, clubs, and business associations.

Perhaps the most concrete demonstration of the commitment of the Chicago scientists to educate the public was the founding of the *Bulletin of the Atomic Scientists*. The first issue of the *Bulletin*, which appeared on December 10, 1945, presented arguments for the importance of international measures to control nuclear development. The *Bulletin* was intended not only for the Met Lab and other Manhattan Project sites, but also for influential nonscientific groups and individuals who could directly affect public policy.

All these efforts achieved a notable success with the passage of the Atomic Energy Act of 1946. Introduced in the Senate as S. 1717 by Sen. Brien McMahon in December 1945, the legislation cleared both houses of Congress by July. Following conference adjustments to its provisions, the bill was signed into law by President Truman on August 1, 1946. The act created the Atomic Energy Commission, a civilian agency charged to take over management of nuclear energy from the Manhattan Project and manage the future development of nuclear power.

World Government

Throughout the duration of the Manhattan Project, the Clinton Engineer Works in Oak Ridge, Tennessee, were administered by the Met Lab offices at the University of Chicago. Scientists at Oak Ridge shared their Chicago colleagues' concerns about the dangers of nuclear weapons and believed conflict could be averted through creation of a world federal government. A group of four Oak Ridge scientists, John L. Balderston, Jr., Dieter M. Gruen, W.J. McLean, and David B. Wehmeyer, decided to promote this idea and gauge support for it through their "Letters on World Government" project.

Letters were written to more than 150 contemporary leaders in science, politics, journalism, literature, and the arts, soliciting their views on the concept of a world government. More than 100 responses were received, from figures as diverse as Albert Einstein, Herbert Hoover, Thomas Mann, Dorothy Canfield Fisher, and Bing Crosby. The committee's report on their project, completed in 1947, was distributed by the Association of Oak Ridge Engineers and Scientists.

Commemorations

After the war, many key Met Lab scientist were recruited by the University of Chicago to join three newly established research institutes on campus: the Institute for the Study of Metals, Institute for Nuclear Studies, and Institute of Radiobiology and Biophysics. Recognizing the historical significance of the CP-1 experiment, these scientists became important contributors to a series of commemorations of the first nuclear reactor. Beginning with a fourth anniversary gathering in December 1946, these events included a tenth anniversary reunion in 1952 and activities marking the twentieth anniversary in 1962.

The passage of time brought inevitable change. Enrico Fermi died in 1954, Arthur H. Compton in 1962. The Stagg Field West Stand, site of the first operating nuclear reactor, was demolished in 1957 and replaced by tennis courts, later joined by Henry Moore's *Nuclear Energy* sculpture. Fermi's longtime collaborator, Herbert Anderson, witnessed the loss of another landmark in 1976, when the "Council Tree" under which the Met Lab scientists had gathered for private discussions was found to be diseased and cut down. Elsewhere on campus, other buildings that had been occupied by the Met Lab -- Eckhart, Jones, Kent, and Ryerson among them – remained in active use as reminders of an extraordinary period in University history and a transformative era in the development of modern science.

Pedestal Cases

Enrico Fermi (1901-1954) won the Nobel Prize for Physics in 1938. He is best known for his leadership of the Manhattan Project team at the University of Chicago, which produced the first controlled self-sustaining nuclear chain reaction on December 2, 1942.

The Smyth Report was the first public account providing details of nuclear research conducted by the United States during World War II. This copy of the book, from the library of Metallurgical Laboratory staff member Melvin Bengston includes signatures of James Franck, Harold Urey, Samuel K. Allison, Eugene P. Wigner, Edward Teller, Herbert L. Anderson, and many other scientists and staff who worked on the Manhattan Project in Chicago.

As World War II drew to a close, the scientists responsible for developing atomic energy became increasingly concerned about the possible use of nuclear weapons for military purposes. In June of 1945, Professor James Franck of the Manhattan Project's Metallurgical Laboratory at the University of Chicago chaired a committee that drafted the "Franck Report," which sought to prevent the United States from using the atomic bomb against Japan. Franck traveled to Washington, D.C., to present the final version of the report to Henry Stimson, the Secretary of War, but the scientists' concerns were not heeded.