CHAPTER 2

The Alchemist's Dream

A Historic Experiment

The sign said "To Squash Courts." As I headed down the hallway, I thought about how long it had been since anyone had played squash down here. Outside, it was a typical Chicago winter day—cold and about 10°F. The effect of the war on our lives was evident everywhere. It was the second day of gas rationing in the city. The streetcars and trains had been jammed on the way to work. This morning's *Tribune* described the Allied assault on Tunisia and told how our soldiers were battling the Japanese for control of New Guinea. Unbeknownst to the general population, today would be historic. In the subterranean squash courts, with oblivious pedestrians overhead, we would attempt something that could change the course of history.

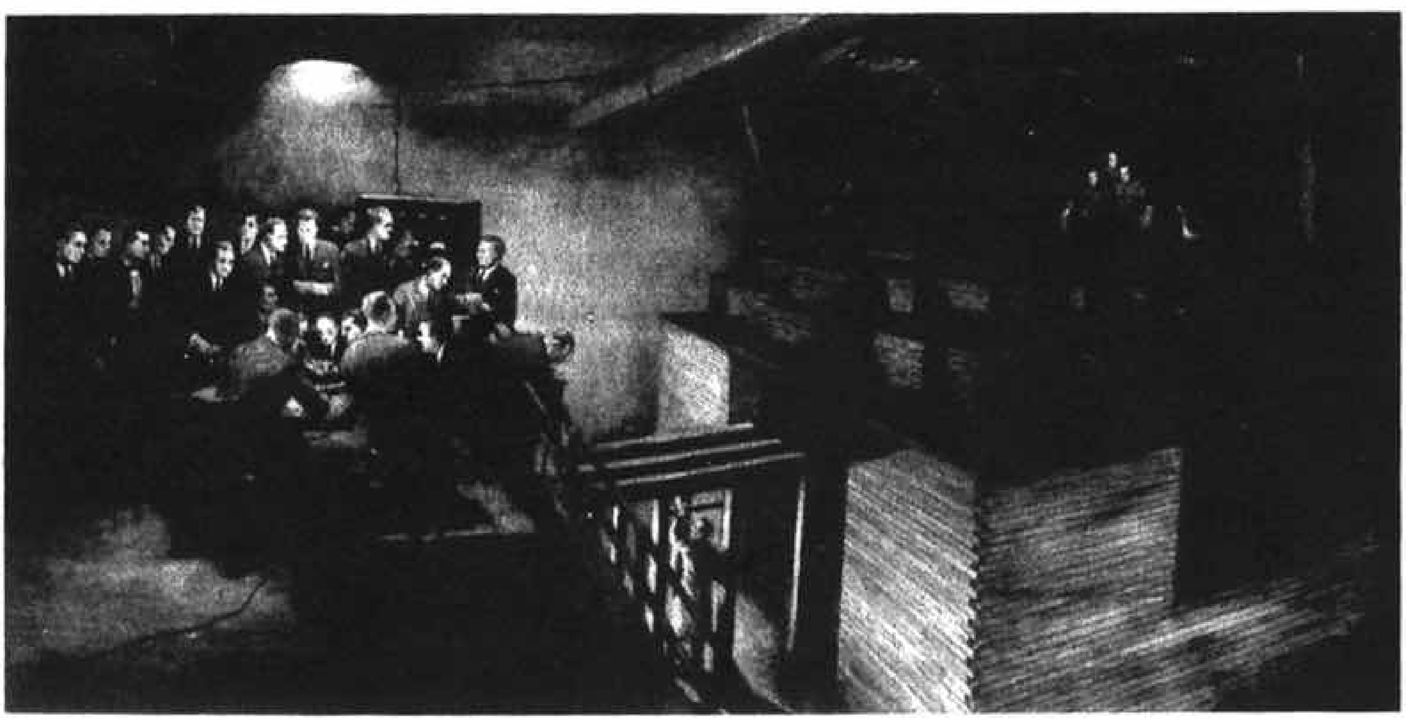
I hadn't slept well. I had kept running through the numbers over and over. What if the calculations were wrong? What if the experiment got out of hand? I had spent the whole night wondering what we might have overlooked. Scientists suffer constantly from this problem. A bit of second guessing could never do any harm, especially when it came to this project. What we were about to attempt wasn't an ordinary laboratory experiment. It had the potential of making the *Hindenburg* seem like a firecracker. I didn't feel comfortable with the shared responsibility. We probably should have told the University of Chicago officials exactly what was happening down in their abandoned squash courts. I remember Arthur Compton, the project leader, telling us why he hadn't explained the dangers to the university's president. "The only answer he could have given would have been no. And this answer would have been wrong."

At the end of the hall, I stopped to show my ID to the guard. Security checks didn't bother me anymore. They seemed a normal part of life now. My breathing quickened as I opened the door and entered the laboratory. The air smelled dusty. Black dust lightly covered the walls, floors, and hallways. But after all, we had moved 80,590 pounds of refined uranium oxide, 12,400 pounds of uranium metal, 771,000 pounds of graphite, and countless pieces of electronic equipment into the area. Who would have imagined that less than a decade ago, college students slammed little balls against these walls to test their agility and deviousness? Today the room was a sea of dark suits. Several colleagues stood on the platform that overlooked the pile of dark metallic ore in the center of the room. There was something uneasy about the tone of their voices. It was little comfort to know that I wasn't alone in my anxiety.

I lingered at the edge of the platform for a minute to gaze at the pile. It seemed so simple. To me, it was a beautiful structure, a work of art. The pile consisted of alternating layers of solid graphite bricks and bricks drilled out so they could contain two short, rounded cylinders of compressed uranium oxide powder. Interspersed were rods of cadmium supported on wood, the ends of which stuck out of the pile with attached handles. Then there were the buckets of cadmium sulfide solution. These were our neutron-absorbing fire extinguishers. They were held in ready by three courageous scientists positioned above the pile. The technicians behind me were running various tests, throwing switches, reading meters, and scribbling notes into lab books. Their instruments included redundant boron trifluoride counters for measuring low neutron intensities, as well as ionization chambers for high-intensity readings. All these sounds blended into a steady whine. I stared at the pile and thought about the events that had led up to the experiment we would perform today.

It was still hard to believe what three simple solids could do. At the blackboard the idea looked so simple, so elegant. To me, much of science seems like that. But putting theory into practice was something different. We had all worked hard and long, not to mention the money that this work had required. It would all begin when one uranium nucleus absorbed one neutron. This new nucleus would be unstable, splitting into barium and krypton, which would release three high-energy neutrons and heat. On average, one neutron in produces two to three neutrons out. Simply amazing! I still remember the feeling of excitement the first time I contemplated the possibility of a sustained and controlled nuclear chain reaction. In practice, natural uranium oxide ore (U_2O_3) could not be used. I had overseen the development of chemical techniques needed to purify the metal and produce the refined oxide (UO_2) that was being used today. The speed of the neutrons also had to be moderated so they could be captured by uranium nuclei. This was the purpose of graphite. Who would ever have thought that pencil lead would be used in the core of a nuclear reactor? The last component, on which our lives depended, was the cadmium. A runaway chain reaction would produce more heat than that needed to transform the pile into a molten mass. Our converted squash courts could become a raging inferno and shower the South Side of Chicago with radioactive fallout. All hope of surviving the experiment relied on the cadmium rods. Laboratory experiments showed that cadmium was an excellent neutron absorber. The cadmium rods should control the neutron flux in the pile. They were our brake pedal. But just to be sure, we were ready to flood the monolith with solutions of cadmium sulfide on a moment's notice.

After an aborted morning test, the moment of truth was at hand. Tension mounted in the room, and I felt both queasy and excited. Eating lunch hadn't been a wise decision. I glanced around the room. Everyone was in his designated place. Enrico Fermi, our scientific leader, gave the command to proceed with the test of his brainchild. Slowly, the cadmium control rods were withdrawn from the pile. My ears strained to hear the clicks that the scalars would make when the detectors in the pile began registering neutrons. These small devices would tell us whether the work was a success or a failure. Nervously, my friends with the buckets of cadmium sulfide readied themselves for the worst. The scalars increased their rates of clicking for a short while, and then the clicking sound became steady. The pile was undergoing a large-scale nuclear reaction. We slid the cadmium rods further out of the pile. The clicking increased to a roar. We hoped that we were in complete control of a nuclear reaction! I watched the pen climb on the chart recorder for what seemed like an eternity, at the end of which Enrico Fermi ordered the control rods inserted to quench the reaction. At 3:53 P.M. central time on December 2, 1942, the road to nuclear power was paved, open, and ready for traffic.



An artist's rendition of the first controlled nuclear fission reaction, The Chicago Pile. (The Chicago Historical Society. Painting by Gary Sheehan (1964. 521.))