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Recollections of a Nuclear War

Two nuclear bombs were dropped on Japan 50 years ago this month. The author, a member of the Manhattan Project, reflects on how the nuclear age began and what the post–cold war future might hold

by Philip Morrison

Rarely do anniversaries mark the very beginning of an event. The roots of my own recollections of the Manhattan Project and the first nuclear bomb go back well before August 1945. One thick taproot extends down to 1938, when I was a graduate student in physics and a serious campus activist at the University of California at Berkeley. One night that spring, my friends and I stayed up into the chilly small hours just to catch the gravelly voice of the Führer speaking at his mass rally under the midday sun in Nuremberg. His tone was boastful, his helmeted armies on the march across national borders. His harangue, though delivered across the ocean and nine hours to the east, sounded all too nearby. It was clear that a terrible war against the Third Reich and its Axis was not far off. The concessions to Hitler made at Munich that autumn confirmed our deepest anxieties. World war was close.

A fateful coincidence in nuclear physics soon linked university laboratories to the course of war and peace. By early 1939 it became certain that an unprecedented release of energy accompanies the absorption of slow neutrons by the element uranium. I can recall the January day when I first watched in awe the green spikes on the oscilloscope screen that displayed the huge amplified pulses of electrons set free by one of the two fast-moving fragments of each divided uranium nucleus.

The first evidence for this phenomenon had been published only weeks earlier. It was indirect, even enigmatic. The radiochemists in Otto Hahn's laboratory at the Kaiser Wilhelm Institute of Chemistry in Berlin—there were none better—had found strong residual radioactivity in barium, which formed as a reaction product when uranium absorbed neutrons. Notably, a barium atom is only a little more than half the weight of an atom of uranium, the heaviest element then known. No such profound fragmentation after neutron capture had ever been seen. The identification was compelling, but its implications were obscure.

Almost at once two refugee physicists from Nazi Germany, Otto R. Frisch and Lise Meitner (Frisch's celebrated aunt), meeting in Sweden, grasped that the nucleus of uranium must have been split into two roughly equal parts, releasing along the way more energy than any nuclear reaction seen before. Soon this news was out, first carried to the U.S. by the Danish physicist Niels Bohr.

Furthermore, the division process, known as fission, seemed intrinsically likely to set free at least two neutrons each time. Two neutrons would follow the first fission, and if conditions were right, they would induce two more fission events that would in turn release four additional neutrons. Fission resulting from these four neutrons would produce eight neutrons, and so on. A geometrically growing chain of reactions (an idea Leo Szilard, a refugee from Europe newly come to New York City, alone had presciently held for some years) was now expected. The long-doubted, large-scale release of nuclear energy was finally at hand. We all knew that the energy released by the fission of uranium would be a million-fold greater pound for pound than that from any possible chemical fuel or explosive.

The World at War

Relevance to the looming war was inevitable. After hearing the news from Europe, my graduate student friends and I, somewhat naive about neutron physics but with a crudely correct vision, worked out a sketch—perhaps it would be better dubbed a cartoon—on the chalkboards of our shared office, showing an arrangement we imagined efficacious for a bomb. Although our understanding was incomplete, we knew that this device, if it could be made, would be terrible. I have no documentation of our casual drawings, but there are telling letters sent by our theorist mentor J. Robert Oppenheimer, whose own office adjoined ours. On February 2, 1939, he wrote his old friend in Ann Arbor, physicist George E. Uhlenbeck. Oppenheimer summarized the few but startling facts and closed: "So I think it really not too improbable that a ten centimeter cube of uranium deuteride…might very well blow itself to hell."

In time, just that would happen, although the process was more complicated than anyone first imagined. I am quite confident that similar gropings took place during those first weeks of 1939 throughout the small world of nuclear physics and surely in Germany, where fission was first found. By the autumn of 1939 Bohr and John A. Wheeler had published from Princeton the first full analysis of fission physics. Gallant Madrid had fallen, and the great war itself had opened. It is a matter of record that by the spring of 1940 several groups of experts had been charged to study the topic in no fewer than six countries: Germany, France (as a nation, soon to become a prisoner of war), Britain, the Soviet Union, the U.S. and Japan. It was certainly not statesmen or military leaders who first promoted the wartime potential of the fission process, but physicists in all these countries. In the U.S., for example, Albert Einstein signed the famous letter to President Franklin D. Roosevelt, just as the war began, encouraging him to pursue the development of nuclear weapons.

By the end of 1941 all those powers, and Italy, too, were immersed in war, as China and Japan long had been. Physics, of course, was fully caught up in the sudden, sweeping American mobilization. By then I was a physics instructor at the University of Illinois at Urbana-Champaign, where I had moved in 1941 to fill an opening left by two of my Berkeley physicist friends, as first one and then his replacement had come and gone again, both bound for some undisclosed war work. In 1942 most male students marched singing to their classes in military formations, students at the pleasure of the draft authorities. The college year was extended to a full 12 months; we faculty members taught full tilt and embarked as well on war-directed investigations with generous federal support.

Another fateful voice now informs my memories. Every Thanksgiving the physicists of the Midwest met in Chicago. I went to their sessions in 1942. A fellow graduate of our small Berkeley group charged me by telephone to come without fail to visit him at the University of Chicago lab where he worked at the time. I entered that Gothic physics building, my appointment verified by unforeseen and incongruous armed guards, to find my friend Bob Christy sitting quietly at his desk. "Do you know what we're doing here?" he asked. I admitted that it was easy to guess: this must be the hidden uranium project to which so many others had gone. "Yes," he said, in his familiar style of calm speech, "we are making bombs."

I was startled, even hushed, by the ambitious plan with so final and fearful a goal. Christy and I talked, and a question arose: How else could our side lose the war unless it was the Germans who first made nuclear weapons? The task was indeed vital; every physicist with relevant competence—they were few enough—had to take part. I was persuaded; my wife concurred. Within weeks I was in the very same Chicago lab, learning how to assist Enrico Fermi, who was in the office next door. I had enlisted, so to speak, for the duration, like many a young soldier before me.

During the bitter war year of 1943, I became an adept neutron engineer, testing again and again detailed mock-ups of the huge reactors to be built in Hanford, Wash., along the Columbia River. I recall other lines of thought, too, within the busy circle of theorists and engineers around Eugene P. Wigner. I recognized almost as a revelation that even the small concentration of uranium found in abundantly available granite could provide enough fission fuel to power its own extraction from the massive rock and yield a large energy surplus besides. In principle only—practice does not even today support this dream—an energy source that could use as fuel the mountains themselves would far outlast all fossil fuels. I was also to propose (not alone) a detailed plan to ferret out what the Germans were in fact up to, and soon I became a technical adviser to General Leslie R. Groves's new intelligence organization in Europe—a dramatic and, in the end, worrisome sideline for a young physicist.

Building the Bomb

Here in the States, two giant industrial sites were being swiftly built to produce sufficiently large quantities of two distinct nuclear explosives, uranium and a newly discovered element, plutonium. And we all knew that somewhere—at a hidden "Site Y"—work was under way to develop a bomb mechanism that could detonate these nuclear explosives. But in mid-1944, even as the reactors along the Columbia that would produce plutonium were being completed by 40,000 construction workers, Site Y encountered an unforeseen technical crisis. The favored bomb design had been simple and gunlike: a subcritical enriched uranium bullet was fired into a matching hole in a subcritical enriched uranium target, detonating them both. Yet measurements on early samples proved that this design could not be used with plutonium, and the bulk of the bomb material the U.S. was prepared to make during the next years would be plutonium. A complex and uncertain means of assembly, known as the implosion design, examined earlier but set aside as extremely difficult, now seemed the only way open: you had to squeeze solid plutonium metal to a momentary high density with a well-focused implosion of plenty of ordinary high explosive.

By summer's end of 1944, I was living and working in Site Y amid the beautiful high mesas and deep canyons of Los Alamos, N.M., along with many other scientists and engineers. We had been urgently gathered from the whole of the wide Manhattan Project to multiply and strengthen the original Los Alamos staff, star-studded but too few to realize the novel engineering of the implosion design.

Information from German labs convinced us by the close of 1944 that the Nazis would not beat us to the bomb. In January 1945, I was working in Frisch's group, which had become skilled in assembling subcritical masses of nuclear material that could be brought together to form the supercritical mass needed for energy release. Indeed, we had the temerity to "tickle the dragon's tail" by forming a supercritical mass of uranium. We made a much subdued and diluted little uranium bomb that we allowed to go barely supercritical for a few milliseconds. Its neutron bursts were fierce, the first direct evidence for an explosive chain reaction.

By spring the lab had fixed on a design for a real plutonium implosion bomb, one worked out by Christy, and scheduled its full-scale test. Two of us from the Frisch group (I was one, physicist Marshall G. Holloway the other) had been appointed as G-engineers, the "G" short for gadget—the code name for the implosion bomb. We were fully responsible for the first two cores of plutonium metal produced. We had to specify their design in great detail; once enough plutonium compound arrived, we were charged to procure the cores from Los Alamos resources, prepare their handling and by July be ready to assemble the first test core amid the other systems of the complex weapon. By June, though, the battle with Germany was over, but the war with Japan burned more terribly than ever. We kept on toward the still uncertain bomb, in loyal duty to our country and the leaders we trusted—perhaps too much?

The Trinity Test, the first test of a nuclear bomb, went off as planned, on July 16, 1945, leaving lifelong indelible memories. None is as vivid for me as that brief flash of heat on my face, sharp as noonday for a watcher 10 miles away in the cold desert predawn, while our own false sun rose on the earth and set again. For most of the 2,000 technical people at Los Alamos—civilians, military and student-soldiers—that test was the climax of our actions. The terrifying deployment less than a month later appeared as anticlimax, out of our hands, far away. The explicit warning I had hoped for never came; the nuclear transformation of warfare was kept secret from the world until disclosed by the fires of Hiroshima.

Nuclear War in Embryo

All three bombs of 1945—the test bomb and the two bombs dropped on Japan—were more nearly improvised pieces of complex laboratory equipment than they were reliable weaponry. Very soon after the July test, some 60 of us flew from Los Alamos to the North Pacific to assist in the assembly of these complex bombs, adding our unique skills to those of scores of thousands of airmen on Tinian, where unending shiploads of gasoline and firebombs were entering the harbor.

The Hiroshima bomb, first to be readied, was first to be used, on August 6, 1945. That city was turned to rust-red ruin by the uranium bomb nicknamed Little Boy. The design had never been tested before it was dropped, as the gun design was so simple, though much costlier in nuclear fuel. Then the second version of the just tested plutonium implosion bomb Fat Man brought disaster to Nagasaki. The war soon ended.

With the sense that I was completing my long witness to the entire tragedy, I accepted the assignment to join the preliminary American party hurriedly sent from our Pacific base to enter Japan on the first day of U.S. occupation. Joined by two other young Americans in uniform, I traveled by train for a couple of weeks across Japan, the rails crowded with demobilizing troops. The Japanese were disastrously impoverished and hungry, yet still orderly. Along the tracks, we saw cities large and small, ruined by 100 wildfires set with jelly gasoline by raids of up to 1,000 B-29 bombers, devastation that was the very mark of the old war. The damage in these other cities resembled the destruction visited on Hiroshima by one single nuclear explosion and its aftermath of fire.

We had loosed our new kind of war, nuclear war in embryo, with only two bombs. A single bomber was now able to destroy a good-size city, leaving hundreds of thousands dead. Yet there on the ground, among all those who cruelly suffered and died, there was not all that much difference between old fire and new. Both ways brought unimagined inferno. True, we saw hundreds of people lying along the railway platform at Hiroshima; most of them would die from burns or from the new epidemic of radiation sickness that we had sowed. But many other cities, including firebombed Tokyo, where 100,000 or more had died in the first fire raid, also counted hosts of burned and scarred survivors. Radiation is no minor matter, but the difference between the all-out raids made on the cities of Japan and those two nuclear attacks remains less in the nature or the scale of the human tragedy than in the chilling fact that now it was much easier to destroy the populous cities of humankind. Two nuclear bombs had perhaps doubled the death count brought by air power to Japan.

Fission and then fusion offered havoc wholesale, on the cheap. It was not World War II that the atom's nucleus would most transform but the next great war. The past 50 years have been ruled by one nuclear truth. In 1945 the U.S. deployed about 1,000 long-range B-29s. By the 1960s we had about 2,000 jet bombers, and by the 1980s maybe 1,500 missiles. For more than four decades we kept a striking force comparable with the one General Curtis E. LeMay commanded in 1945, each year becoming faster, more reliable, and so on. But now every single payload was not chemical explosive but nuclear fire, bringing tens or even hundreds of times greater death and destruction. The statesmen on both sides chose to arm and even threaten war with these weapons, a war that would be orders of magnitude more violent than all before it. Yet the statesmen did not follow through on their threats; large-scale nuclear conflict is now recognized for what it is, wholly intolerable.

I returned from Japan at the end of September 1945 to learn that one young man within our small group was gone, killed in the lab by a runaway radiation burst. (He would not be the last, either.) Our temerity about the nuclear dragon had left its legacy in New Mexico as well. America was at peace but clamorous, the new atomic bomb, in all its terror, the center of interest. By the end of the year many scientists, including myself, made clear, concerted, even dramatic public statements about the future of nuclear war. What we said then was this: Secrecy will not defend us, for atoms and skills are everywhere. No defenses are likely to make up for the enormous energy release; it will never be practical to intercept every bomb, and even a few can bring grave disaster. Passive shelter is little use, for the deeper the costly shelter, the bigger the inexpensive bomb. No likely working margin of technical superiority will defend us either, for even a smaller nuclear force can wreak its intolerable damage.

Legacy of the Bomb

I think these views are as right today as they were in 1945. Only one way remains: comprehensive international agreement for putting an end to nuclear war, worked out in rich detail. It is striking that the laboratory leaders of the Manhattan Project said much the same thing as early as August 17, 1945, three days after the peace was made with Japan. But they wrote in secret to the U.S. secretary of war, and their first views remained hidden for many years.

The 1990s have given us an unexpected historical opportunity, as unexpected as was fission itself. The U.S. and the former Soviet Union are right now dismantling some eight or 10 nuclear warheads every day, yet both have a long way to go. We have never had so promising and so concrete an omen of peace, but it is still mainly promise. We need resolute and widespread action. The task is not simple, but was any international goal more important than securing the future against nuclear war? How could we ever have planned war with tens of thousands of nuclear warheads? Did we not know that America would lie in ruin as well? With nuclear weapons, war achieves a final, futile symmetry of mutual destruction.

In 1963 Oppenheimer recalled that when Bohr first came to Los Alamos during the war, the visitor asked his friend and host very seriously: "Is it big enough?" Oppenheimer knew just what Bohr meant: Was this new scale of warfare big enough to challenge the institution of war itself? "I don't know if it was then," Oppenheimer wrote, "but finally it did become big enough." Then it became frighteningly too big, and it is still far too big, but at least no longer is it luxuriantly growing. We can, if we persist, end its unparalleled threat.

The Author

PHILIP MORRISON was born in Somerville, N.J., in 1915 and spent the years from late 1942 until mid-1946 working on the Manhattan Project. He taught physics at Cornell University from 1946 to 1965. He then moved to the Massachusetts Institute of Technology, where he is now professor emeritus. Since 1945 Morrison has talked and written, at last rather hopefully, about avoiding a second nuclear war. He has enjoyed reviewing books for this magazine in nearly every issue of the past 350 months.

Further Reading

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