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The History of a
Scientific Community in
Modern America

THE PHYSICISTS

by
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XXI

The Bomb and Postwar Research Policy

In early 1939 Enrico Fermi, now a Nobel laureate and refugee from Italy, gazed thoughtfully out his office window high in the Columbia physics building. In the laboratory Fermi had been investigating the recent report of the German and Austrian scientists Otto Hahn and Lise Meitner that uranium atoms fissioned upon impact by neutrons. Now, looking toward the expanse of Manhattan beyond the pane of glass, Fermi shaped his hands into a large-sized ball. A little bomb like that, he remarked, and it would all disappear.[1]

Hahn and Meitner's startling discovery stimulated a number of physicists, native and refugee alike, to think of a nuclear explosive. In the process of fission, a large quantity of energy was released, and so were more neutrons, possibly enough to make a chain reaction. Certain that the Germans would recognize the same possibility, in the summer of 1939 the refugee physicists Eugene Wigner and Leo Szilard prevailed upon Einstein to call FDR's attention to the military implications of nuclear fission. A committee was formed, and $6,000 appropriated. But the committee members, thinking of fission as a potential source of peaceful industrial power, gave the government's uranium project little push or direction. Anxious to explore the possibilities of a nuclear weapon, Wigner and his colleagues felt as if they were "swimming in syrup."[2]

[1] Interview with George Uhlenbeck, who at the time shared the office with Fermi.

[2] Wigner, "Are We Making the Transition Wisely?" *Saturday Review of Literature*, 28 (Nov. 17, 1945), 28.

In June 1940, authority over the program was transferred to NDRC and Vannevar Bush. Mindful of maintaining balance in the defense research program—and half hoping that an atom bomb might be impossible—Bush refused to embark on a major nuclear weapons program, especially since it could prove to be a wild goose chase.[3] Chief among the numerous obstacles to the bomb was the natural occurrence of uranium as a mixture of two isotopes, U-235 and the slightly heavier U-238. The fissionable isotope was U-235, which amounted to only 1 part in 140 of ordinary uranium. An explosive chain reaction would require a still undetermined number of kilograms of nearly pure U-235, yet no one knew an obviously easy way to separate even a few grams of U-235 from the more abundant U-238.

But in mid-1941 optimistic word about the prospects of a uranium bomb came from British scientists. They estimated that the amount of uranium for a "critical mass," in the phrase used to denote the minimum material necessary for a self-sustaining chain reaction, totaled only about 10 kilograms. The British also believed that sufficient U-235 could be separated from U-238 by the method of gaseous diffusion. Already under investigation at Columbia University by Harold Urey and the physicist John Dunning, this technique took advantage of the physical fact that two gaseous substances of different weights diffuse through a porous barrier at different rates. Forced through a sufficiently long cascade of porous barriers, the lighter U-235 would eventually be separated from the heavier U-238. Adding to the encouraging news from the British, in Berkeley Ernest Lawrence had begun work on separation by electromagnetic means. Moving in a magnetic field, identically charged ions of different weights follow different trajectories. If uranium ions were sent through the magnetic field of a cyclotron, the ions of U-235 would be eased away from those of U-238 and made available for collection.

Lawrence's imagination was also fired by the results of experiments with U-238 in his cyclotron. Early in 1941, Glenn T. Seaborg, a young physical chemist at Berkeley, had demonstrated that, after bombardment with neutrons, U-238, which was element 92 in the periodic table, eventually transformed itself into a new element 94, which Seaborg christened plutonium. Furthermore, as expected on theoretical grounds, plutonium fissioned just like U-235. The striking implication: Fashioned into a chain-reacting pile, all the abundant, nonfissioning U-238 could be transformed into fissionable plutonium suitable for an atomic explosive.

During the spring and summer of 1941 Lawrence, soon joined vigorously by Arthur Holly Compton, insisted to Bush and Conant that, if only because of what the Germans might be doing, prudence required stepping up atom bomb research. In October a persuaded Bush obtained President Roosevelt's go-ahead for a major attempt to test whether a bomb could

[3] Bush to Jewett, May 2, 1940, VB, Box 55, file 1375.

actually be developed in time for use in the current war. Shortly after Pearl Harbor, his sense of urgency now acute, Compton decided that the scientific side of the question, then under investigation by geographically isolated groups, would be better explored in a concerted fashion. In January 1942 he brought various teams of physicists, including Fermi's from Columbia, to the University of Chicago and organized them into the Metallurgical Laboratory. The misleading name veiled its main immediate purpose: the achievement of a chain reaction to test the feasibility of producing plutonium in an atomic pile.

In June 1942, with the favorable scientific evidence steadily mounting, FDR gave Bush the green light for a full-scale effort to build the bomb. Aware that the operation would require an industrial effort far beyond the managerial capacities of OSRD, Bush and Conant arranged for the assignment of process development, engineering design, procurement of materials, and the selection of plant sites to a new Manhattan District of the Army Engineers. In September, command of the Manhattan Project was given to Brigadier General Leslie R. Groves, the builder of the Pentagon, brisk, efficient, supremely self-confident, and decidedly able. Under Groves, the direction of physical and chemical research for the bomb remained in the hands of three civilian program chiefs: for gaseous diffusion, Harold Urey at Columbia University; for electromagnetic separation and plutonium studies, Ernest Lawrence at Berkeley; and for weapon theory and chain reactions, Arthur Holly Compton at Chicago.

While Compton handled administration and policy at the Chicago Metallurgical Laboratory, Enrico Fermi masterminded the construction of a chain-reacting pile in a squash court under the west stands of Stagg Field, the university's unused football stadium. Physicists hand-hauled into place heavy graphite blocks—they were needed to slow the neutrons—seeded in uranium slugs, and gradually built up an arrangement resembling a flattened sphere about twenty-six feet in diameter. Finally, on December 2, 1942, almost four hundred tons of graphite were in place, together with six tons of uranium metal and fifty tons of uranium oxide. Under Fermi's direction, the reaction control rods were slowly withdrawn. The clicks of the neutron counters rose steadily, like a mounting frenzy of crickets. Fermi, raising his hand, announced that the pile had gone critical. A while later, Arthur Compton telephoned Conant at Harvard: "Jim, you'll be interested to know that the Italian navigator has just landed in the new world."[4]

Later that month, President Roosevelt approved the expenditure of $400,000,000 for uranium separation plants and a plutonium-producing pile. In 1943, moving decisively, Groves let contracts for the construction

[4] Arthur Holly Compton, *Atomic Quest: A Personal Narrative* (New York, 1956), p. 144.

of gaseous diffusion and electromagnetic facilities at Oak Ridge, Tennessee, a 59,000-acre governmental reservation that the army had acquired for the purpose. He also ordered the construction of the plutonium works on 400,000 federal acres near the Columbia River at Hanford, Washington.

When representatives of Stone and Webster, the prime contractor for the electromagnetic plant, first visited Berkeley, they came away shaking their heads in awe at the way Lawrence's skyscraper plans rested so far on the successful separation of only a few millionths of a gram of U-235.[5] Lawrence, his gusto for the impossible intensified by the war emergency, drove his staff day and night. In a cut-and-try fashion, Berkeley physicists and engineers designed vacuum tanks, ionization apparatus, U-235 collectors, and magnets. Forced by the shortness of time to skip the pilot-plant stage, Stone and Webster went from the Berkeley designs directly to the building of the vacuum separation chambers and the huge steel magnet ovals. The chambers contained an unprecedentedly enormous volume of evacuated space; the magnet coil windings required more than 28,000,000 pounds of silver (the metal, worth $400,000,000, was borrowed from the Treasury Department). When the racetracks, as the electromagnetic system was dubbed, were first operated in late 1943, electrical shorts and vacuum leaks erupted everywhere. In 1944, after major repairs, breakdowns still plagued the system, so Lawrence brought squads of scientists and technicians from Berkeley to trouble-shoot the equipment. The racetracks would work, Lawrence assured a discouraged General Groves.[6]

Even more prodigious efforts were required for the gaseous diffusion process, the key to which was the development of a suitable diffusion barrier. The barrier had to have millions of tiny holes, be impervious to the exceptionally corrosive effects of uranium hexafluoride gas, and possess sufficient structural strength to withstand high pressures. After months of research at Columbia, Bell Telephone Laboratories, and elsewhere, Percival C. Keith, in charge of the diffusion process for the prime contractor, the Kellex Corporation, despaired that the barrier problem would ever be solved; so even did Ernest Lawrence, who urged deemphasis of the diffusion method. But not Bush, Conant, or Groves, who boldly pushed ahead the construction of literally acres of diffusion cascades at Oak Ridge. Industrial physicists, chemists, and engineers performed prodigious feats of design and development to fabricate corrosion-resistant valves, pipes, and pumps. In the fall of 1943 Clarence A. Johnson, a young engineer working for Keith's corporation, hit upon a promising idea for the barrier, one that fused elements of the existing

[5] Stephane Groueff, *Manhattan Project: The Untold Story of the Making of the Atomic Bomb* (Boston, 1967), pp. 36–37.

[6] Herbert Childs, *An American Genius: The Life of Ernest Orlando Lawrence* (New York, 1968), p. 345.

approaches with an originality of its own. At Columbia, Urey, grown increasingly pessimistic and temperamental under the stress of the barrier project, refused to divert his laboratory to the pursuit of Johnson's idea. Keith maneuvered into control of the project the Princeton chemist Hugh Scott Taylor, who, aided by academic and industrial scientists as well as his own ingenuity and sense, inched barrier design and production successfully forward.[7]

Still, in mid-1944 the barrier problem was not yet completely solved. In desperation, Groves ordered the installation at Oak Ridge of yet another type of separator, a thermal diffusion plant. The idea of the physical chemist Philip Abelson, who had worked on it independently for three years with naval support, thermal diffusion exploited the propensity of atoms of different weights to separate when caught between hot and cold surfaces. Thermal diffusion could increase the percentage of U-235 in natural uranium by only a small amount. But the degree of enrichment might be sufficient to replace the gaseous diffusion method as the expected source of material for the electromagnetic separators.

The plutonium project required a grit and ingenuity all its own. The cyclotron at Washington University in St. Louis was enlisted to make experimental samples of the new element by bombarding U-238 with neutrons night and day. Working with mere micrograms of the material, chemists under Glenn Seaborg at the Metallurgical Laboratory devised production techniques for the chemical separation of plutonium from uranium. In 1943 physicists and chemists left Chicago for Oak Ridge, where they designed and built an experimental pile and separation facilities; at the end of the year the equipment yielded the first milligrams of plutonium. Among the Oak Ridge staff was Eugene Wigner, who came up with a basic design for the pile at Hanford which was adopted by the scientists and engineers of the prime contractor, the Du Pont Company. In 1944, the completed Hanford pile was turned on. It went critical for some minutes, then the chain reaction stopped.

Tests showed that the pile was producing an isotope of the element xenon, which poisoned the chain reaction by absorbing large quantities of neutrons. The effect had never showed up in the Oak Ridge pile because, contrary to Groves's instructions, the staff had never run it at full power. Groves was angry and, along with Compton, decidedly worried. But the young physicist John Wheeler of Princeton University, who with Bohr had written the fundamental paper on the theory of fission, had warned the Du Pont staff about the possibilities of poisoning. Over the opposition of a number of scientists at Oak Ridge and Chicago, and at the insistence

[7] Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World, 1939/1946* (*A History of the United States Atomic Energy Commission*, Vol. I; University Park, Pa.: Pennsylvania State University Press, 1962), pp. 133–36; Richard G. Hewlett, "Nuclear Physics in the United States during World War II," unpublished manuscript, pp. 20–21.

of George Graves, an assistant technical adviser in the company, Du Pont engineers had designed room in the pile for excess uranium slugs. Stuffing the pile to the maximum, the Hanford staff overwhelmed the poisoning effect. Du Pont people could be forgiven their celebratory doggerel about Graves, who "with baleful glare . . . /Cried, 'Dammit, give it stuff to spare— / The longhairs may have missed.' "[8]

By early 1945 the Hanford facilities were beginning to turn out pure plutonium. By the same time, the barrier problem had been overcome at Oak Ridge. There, operating in tandem, the thermal diffusion assembly, the racetracks, and the gaseous diffusion cascades were yielding U-235 of high purity in steadily increasing quantities. But long before either plant reached full production, both had started sending their small first yields of plutonium and enriched U-235 to the apex of the Manhattan Project, the special weapons laboratory that Groves had established under J. Robert Oppenheimer at Los Alamos, New Mexico, a lonely mesa nestled 7,500 feet up in the majestic Sangre de Cristo Mountains some seventy-five miles north of Albuquerque.

From its opening in March 1943, Los Alamos absorbed physicists like a sponge. The Rad Lab was losing its best theorists to the bomb effort, Rabi complained to Bush, and if the losses continued, advanced radar research would be seriously impaired. Nevertheless, the high priority of the Manhattan Project permitted the Los Alamos scientific and technical staff to grow, by spring 1945 to well more than two thousand, including some six hundred army enlisted men assigned to the laboratory as part of a Special Engineering Detachment. The scientists ranged from first-degree apprentices—the median age of the technical staff was twenty-seven—to native, refugee, and British physicists whose names were already textbook fixtures. To Frederic de Hoffman, a new Ph.D. from Harvard, his arrival at Los Alamos seemed like "one grand final exam day, with all the senior faculty members of all the U.S and European physics faculties assembled to give . . . that final exam."[9] At the Fuller Lodge on the mesa, one could sometimes see as many as eight Nobel laureates dining at once.

The physicists at Los Alamos lived with numerous irritations, including the isolation—it was a hazardous eighty-mile round trip to Santa Fe—the jerry-built housing, and above all the army, with its pervasive security restrictions. Famous physicists played charades with pseudonyms—Niels Bohr was "Nicholas Baker"—and the birth certificates of newborn babies were inscribed "P.O. Box 1663, Sandoval County Rural." Nothing was

[8] Quoted in Compton, *Atomic Quest*, p. 193.

[9] Rabi to Bush, June 1, 1943, OSR, Entry 1, Manhattan District: Personnel Matters; Smith, "Los Alamos: Focus of an Age," in Richard S. Lewis and Jane Wilson, eds., *Alamogordo Plus Twenty-Five Years* (New York, 1971), p. 34; John H. Manley, "Organizing a Wartime Laboratory," in Jane Wilson, ed., *All in Our Time: The Reminiscences of Twelve Nuclear Pioneers* (Chicago: Bulletin of Atomic Scientists, 1975), p. 135; de Hoffman, "A Novel Apprenticeship," *ibid.*, p. 163.

permitted that might indicate to the outside world the identity of the inhabitants. In the laboratories, army engineers sometimes interfered with technical matters in which they had no competence.[1] To the physicists and their families, the army personified was General Groves, who could be infuriatingly pompous, behave as though his judgment were infallible, and take unassailable positions on matters as small as whether the Los Alamos compound should have a west gate. Still, Groves's dedicated attention to the project produced welcome results that ranged from the miracle of getting a scarce B-29 for tests to the thoughtful favor of supplying every household with an electric hotplate when he learned that the wood-burning stoves were difficult to operate. Sometimes reluctantly, Groves also eased military rigidity to accommodate the freewheeling ways of science. And on their part, the scientific staff learned to cope with the isolation, the army, the security restrictions, and each other.

Los Alamos scientists skied and hiked in the remote beauty of the surrounding mountains, gathered at intellectually stimulating social evenings, and kept the maternity ward busy. Way down in the hierarchy, a homesick army recruit from New York hung a bagel from the ceiling so that he could lie back on his bunk and admire it. The future Nobel laureate Richard P. Feynman, then in his early twenties, dealt with the strain by playing the bongo drums, challenging the censors with coded letters, or picking the combination locks of safes containing classified documents. Higher up the ladder, the moody Edward Teller, who was apt to spend his leisure in long walks, insisted at work upon pursuing his own scientific demon, a thermonuclear weapon, and drove his neighbors to distraction by rhapsodizing on the piano at odd hours of the night. Oppenheimer relaxed over writings from the Sanskrit or the poetry of John Donne.

Oppenheimer, the director, his hair cropped efficiently short, mediated between Groves and the scientific staff, easing army regulations, housing problems, and personal crises. At times overwhelmed to the point of despair by the administrative burden, he depended heavily on the hardheaded executive talents of his division leaders and his early assistant John H. Manley, who had helped drive him to an acrimonious outburst one night in Berkeley by nagging about the need for an organizational plan at Los Alamos. Later on, Samuel K. Allison, the Chicago physicist and former head of the Metallurgical Laboratory, became Oppenheimer's associate director and kept track of the numerous details involved in the fabrication of a weapon. But the scientific tone at Los Alamos was shaped principally by Oppenheimer. Despite Groves's vigorous objections at the hazard to security, Oppenheimer refused to compartmentalize the laboratory; he insisted upon holding a weekly progress review open to everyone who wore the white badge that signified an academic degree. "Here

[1] Lansing Lamont, *Day of Trinity* (New York, 1965), pp. 54–55; Robert R. Wilson, "A Recruit for Los Alamos," in Wilson, ed., *All in Our Time*, p. 157.

we have assembled the greatest bunch of prima donnas ever seen in one place," Groves remarked.[2] Through some combination of tough judgment, mystique, and a melancholic sense of the laboratory's terrible goal, Oppenheimer dampened the scientific factionalism, persuaded both apprentices and prima donnas to feel privileged to be cooped up on the mesa, and inspired the entire staff to remarkable feats of research and technical ingenuity.

Much of the technical challenge centered on finding out how a critical mass of U-235 or plutonium would behave in the microsecond between the start of the chain reaction and the explosion. An experimental physics division under Robert F. Bacher laboriously used accelerators as neutron sources to measure the fission properties of the two elements. Exploiting their expertise in the electronic techniques of microwave radar, they devised sensitive equipment to determine the reaction speeds at different neutron energies. Shaping the experimental data into a prediction of critical mass behavior was the task of the theoretical division under Hans Bethe. With his formidable theoretical powers, Bethe, in the observation of Feynman, resembled a battleship surrounded by an escort of smaller vessels, the younger theorists, moving majestically forward through the ocean of the unknown.[3]

Both experimentalists and theorists pondered the key problem of bomb design. To obtain a powerful explosion, sufficient fissionable material to form a critical mass had to be brought together quickly, then kept together long enough to release a lot of energy. The most direct assembly method consisted of using a gun to fire one subcritical mass of fissionable material into another with the speed and force of an artillery shell. But while experiments suggested strongly that the gun method would work for U-235, they also indicated by spring 1944 that it would not work for plutonium.

The trouble was that plutonium emitted many more neutrons spontaneously than did U-235, enough possibly to predetonate the bomb assembly before it could release more than a minute fraction of its potentially explosive energy. But an alternative to the gun method had been proposed in April 1943 by the young Caltech physicist Seth Neddermeyer. Called implosion, this approach relied upon surrounding a mass of subcritical plutonium with high explosives which, when fired, would produce a spherically symmetrical shock wave traveling inward toward the center of the bomb. The shock wave would compress the plutonium into a critical mass and, keeping it compressed while a rapid chain reaction developed, would maximize the energy released. The great speed of compression would also eliminate the danger of predetonation. At first re-

[2] Robert F. Bacher, "Robert Oppenheimer," *Proceedings of the American Philosophical Society*, 116 (Aug. 1972), 281–82; Groves is quoted in Groueff, *Manhattan Project*, p. 204.

[3] Stanislaw M. Ulam, *Adventures of a Mathematician* (New York, 1976), p. 150.

jected as too difficult by most, and scoffed at by some, Neddermeyer's idea acquired increasing luster at Los Alamos as the dangers of a plutonium fizzle became more apparent.

But the array of imploding explosives around the plutonium core would have to yield a spherical shock wave of absolute uniformity. The slightest nonuniformity, and the plutonium would tend to squirt away, halting the chain reaction. In February 1944, Oppenheimer brought in the physical chemist George Kistiakowsky to head a new implosion effort at the laboratory. In early March, Kistiakowsky drew up a day-by-day chart of desirable progress. His final entry, projected for the end of the year: "The test of the gadget failed. Project staff resumes frantic work. Kistiakowsky goes nuts and is locked up!"[4] The pressure on Kistiakowsky's people rose even more after it became clear that, because of the likelihood of spontaneous fission, a plutonium bomb could not be set off by the gun method; it would have to be detonated by implosion.

Mainly to meet the challenge of implosion, Oppenheimer reorganized the laboratory in mid-1944, shifting its emphasis from research to the design and fabrication of both a U-235 and, especially, a plutonium bomb. When Hanford and Oak Ridge began sending production quantities of plutonium and U-235, the tension on the mesa rose precipitously. In January 1945, aware that the cost of the project was close to $2 billion, Groves warned his aides that if the Manhattan Project failed, "each of you can look forward to a lifetime of testifying before Congressional committees."[5]

By early March, the design of the implosion bomb was set in principle, and Oppenheimer appointed a Cowpuncher Committee to ride herd on the final development of the system. By mid-April, Kistiakowsky had overcome the critical problem of the asymmetrical shock wave. In early July, the laboratory moved ahead toward the assembly of the U-235 gun bomb for shipment to the 509th Composite Air Group, a specially trained B-29 unit in the South Pacific. No precombat explosive test of the uranium bomb, code-named Little Boy, appeared necessary; the Los Alamos scientists had high confidence in the gun method. But a trial of the implosion weapon had long seemed imperative. The Cowpunchers worked frantically to ready a plutonium bomb for detonation in the desert near Alamogordo, New Mexico.

On July 16, in the dark before morning, the plutonium gadget rested atop a lone tower in a sheet-metal shack three hundred feet above the desert floor. Outside a ten-thousand-yard radius, scores of men waited, tense, nervous, apprehensive. Oppenheimer, standing in the doorway of the South-10,000 bunker, seemed to totter on the verge of nervous collapse. Kistiakowsky had bet him a month's salary against ten dollars that

[4] Quoted in Hewlett and Anderson, *The New World*, p. 248.
[5] Quoted in Lamont, *Day of Trinity*, p. 76.

the implosion device would work. Samuel Allison brought the countdown to zero with a scream. A spot of light burst through the darkness, then boiled upward, exploding into a rainbow of fire that colored the desert wastes and dazzled the mountain ranges in the distance. Moments later the shock wave blasted through with the roar of twenty thousand tons of TNT. After the first exhilarating cheers of success, there was an awesome silence. Through Oppenheimer's mind flashed a line from the Bhagavad-Gita: "I am become Death, The shatterer of worlds."[6]

Twenty-one days later, at 2:45 A.M. August 6, 1945, three B-29s belonging to the 509th rose from the island of Tinian in the Marianas and headed for Japan fifteen hundred miles to the north. In the belly of the lead plane, the *Enola Gay*, was the uranium bomb, Little Boy. By 7:30 A.M. Navy Captain William S. Parsons, the head of the ordnance division at Los Alamos, had completed arming the bomb. Fifteen minutes later the plane was over the Japanese mainland. "It is 8:50," Captain Robert A. Lewis, who had been jotting a log of the flight, soon noted. "Not long now, folks. . . . There will be a short intermission while we bomb our target." The plane lurched upward when the five-ton bomb fell away toward its detonation point two thousand feet above the city. A few moments later Captain Lewis exclaimed: "My God!"[7] Hiroshima was covered with a great swirling column of smoke that reached thirty thousand feet in less than three minutes and could still be seen when the *Enola Gay* was four hundred miles away.

In the United States later that day, the White House released the news: "Sixteen hours ago an American airplane dropped one bomb on Hiroshima. . . . That bomb had more power than 20,000 tons of TNT. . . . It is a harnessing of the basic power of the universe."[8] Three days later, August 9, 1945, another B-29 from the 509th dropped an implosive plutonium bomb, code-named Fat Man, on Nagasaki.

Within weeks Americans knew fully the grim results of the atomic bombings—from the pictures of Hiroshima and Nagasaki devastated beneath the towering mushroom clouds, from the cold statistics of fire, blast, destruction, and death, from the prompt surrender of Japan. Here and there, notably in liberal religious circles, the atomic bombings of Japan were publicly denounced on moral grounds as cause, in the phrase of *Commonweal*, for "American guilt and shame." Among most people, the nuclear end of the war provoked a jumble of ambivalent feelings, not only joy and relief but doubt, and fear that perhaps science had finally gone too far. There was no comfort to be found in Oppenheimer's flat response to a reporter's query about nuclear weapons: "If you ask: 'Can

[6] Quoted *ibid.*, p. 235.

[7] Quoted in William L. Laurence, *Dawn over Zero: The Story of the Atomic Bomb* (New York, 1946), p. 221.

[8] *Public Papers of the Presidents . . . Harry S Truman, 1945* (Washington, D.C., 1961), p. 197.

we make them more terrible?' the answer is yes. If you ask: 'Can we make a lot of them?' the answer is yes. If you ask: 'Can we make them terribly more terrible?' the answer is probably."[9] Yet pollsters reported that the public backed the use of the atomic bombs against Japan overwhelmingly because it brought the war to a speedy end. And whatever ambivalence the bomb provoked, it sealed a consensus, rapidly emerging even before Hiroshima, about the future requirements of national security.

Vannevar Bush himself publicly attested that, if the enemy's early technological superiority had been slightly greater or more diverse, "Nazi Germany would not now be prostrate." The United States, defense analysts said, managed to surpass German military technology only because the grace period before Pearl Harbor had allowed the nation sufficient time to mobilize her civilian scientific resources. After Hiroshima—as well as the German V-1s and V-2s, those harbingers of intercontinental missiles—it was widely said that there would be no grace period again. The White House had called the atomic bomb the "greatest achievement of organized science in history."[1] Now military officials, civilian analysts, congressmen, and thoughtful observers across the partisan and ideological spectrum agreed: In the atomic age, the United States could not do without a national policy of scientific, especially nuclear, research.

Americans debated the shape of that policy with special attention to the opinions of a newly influential group: the generation of atomic scientists—the Los Alamos generation—that Hiroshima and Nagasaki had brought to the center of the public stage. From the days of John Wesley Powell to those of Robert Millikan, American scientists had scarcely been concealed from public notice. But unlike any of its predecessors, this generation was dominated by physicists who seemed to wear the "tunic of Superman," in the phrase of a *Life* reporter, and stood in the spotlight of a thousand suns.[2]

Long before the glare of publicity, the role of martial superman had provoked a certain queasiness among the atomic scientists. I. I. Rabi had refused to take a full-time post at Los Alamos—was this to be the "culmination of three centuries of physics"?—and in the spring of 1945 he warned: "If we take the stand that our object is merely to see that the next war is bigger and better, we will ultimately lose the respect of

[9] *Commonweal*, 42 (Aug. 24, 1945), 443; Oppenheimer is quoted in *Time*, 46 (Oct. 29, 1945), 30. It is interesting to note that, speaking for the Federal Council of Churches, John Foster Dulles declared of Hiroshima and Nagasaki: "If we, a professedly Christian nation, feel morally free to use atomic energy in that way . . . the stage will be set for the sudden and final destruction of mankind." Quoted in *Time*, 46 (Aug. 20, 1945), 36.

[1] Bush testimony, U.S. Congress, House Committee on Military Affairs, *Hearings, Research and Development*, 79th Cong., 1st Sess., May 1945, p. 4; *Public Papers of . . . Harry S Truman, 1945*, p. 198.

[2] Francis Sill Wickware, "Manhattan Project," *Life*, 19 (Aug. 20, 1945), 100.

the public. In popular demagogy we [will] become the unpaid servants of the 'munitions makers' and mere technicians rather than the self-sacrificing public-spirited citizens which we feel ourselves to be." After the test explosion at Alamogordo, Kenneth T. Bainbridge, the chief of the operation and a shrewd, sensitive human being, turned to Oppenheimer: "Now we're all sons of bitches."[3] Hoping to maintain their scientific, political, and moral integrity, the Los Alamos generation on the whole declared with the Manhattan Project group under the leadership of the Nobel laureate James Franck that scientists could "no longer disclaim direct responsibility for the use to which mankind . . . put their disinterested discoveries."[4]

The Franck group was located at the University of Chicago Metallurgical Laboratory, where in the spring of 1945 the staff, its work for the bomb finished earlier than at other sites, had debated the use of the weapon in the war. Some of the Chicago scientists sided with Leo Szilard, the mercurial, effusive, perceptive Hungarian refugee, who was already appalled at the mass bombings of civilian populations. Sure that atomic bombs were "primarily a means for the ruthless annihilation of cities," Szilard opposed the atomic bombing of Japan on the moral ground that it would open the door "to an era of devastation on an unimaginable scale."[5] Many Metallurgical Laboratory scientists endorsed the earlier, more pragmatic report drawn up by the small group—Szilard among them—under Franck. If the United States were to release this new means of "indiscriminate destruction" without warning, the Franck Report argued eloquently, she would sacrifice her moral position in the world, precipitate a nuclear arms race, and "prejudice the possibility of reaching an international agreement on the future control of such weapons." Better, the report concluded, to warn the Japanese of what they faced, and to reveal this awful weapon to the world, "by a demonstration in an . . . uninhabited area."[6]

[3] Rabi is quoted in Oppenheimer to Rabi, Feb. 26, 1943, JRO, Box 59, Rabi file; Rabi to the Research Board for National Security, April 3, 1945, OV, Box 33; Bainbridge is quoted in Lamont, *Day of Trinity*, p. 242.

[4] James Franck et al., "A Report to the Secretary of War, June 1945," in Morton Grodzins and Eugene Rabinowitch, eds., *The Atomic Age: Scientists in National and World Affairs* (New York, 1963), pp. 19–20.

[5] Leo Szilard, "A Petition to the President of the United States, July 3, 1945," appended to Szilard, "Reminiscences," in Donald Fleming and Bernard Bailyn, eds., *The Intellectual Migration* (Cambridge, Mass., 1969), pp. 150–51; Szilard, "A Petition to the President of the United States, July 17, 1945," Grodzins and Rabinowitch, eds., *The Atomic Age*, pp. 28–29. Szilard told Oppenheimer that from the "point of view of the standing of the scientists in the eyes of the general public one or two years from now it is a good thing that a minority of scientists should have gone on record in favor of giving greater weight to moral arguments" than to pragmatic ones. Quoted in Martin J. Sherwin, *A World Destroyed: The Atomic Bomb and the Grand Alliance* (New York, 1975), p. 217.

[6] Franck et al., "A Report to the Secretary of War, June 1945," Grodzins and Rabinowitch, eds., *The Atomic Age*, p. 27.

But not all Manhattan Project scientists, at Chicago or elsewhere, agreed with the Franck Report. Particularly important were the high-level scientists giving advice on nuclear policy to Secretary of War Stimson, who had become accustomed to taking seriously the opinions of scientists on strategic matters. A scientific panel consisting of Oppenheimer, Arthur Compton, Enrico Fermi, and Ernest Lawrence concluded in mid-June 1945: "We can propose no technical demonstration likely to bring an end to the war; we can see no acceptable alternative to direct military use."[7] Neither could Bush, Conant, or Karl Compton, who, at an advisory level closer to Stimson, had already joined in a recommendation that the bomb should be dropped without warning upon a military installation surrounded by workers' housing. Stimson and his scientific advisers expected that using the bomb in this manner would most likely achieve their primary aim of bringing the war to a speedy end. Some also believed that such a course might further, not impair, the prospects of postwar amity, since the indisputable proof of the bomb's destructiveness would force the world to recognize the imperativeness of peace.

Whatever their differences, even before Hiroshima the scientists who supported the Franck Report and those who sided with Stimson's advisers did agree on two points: The postwar peace would hinge on the establishment of some system of international control of nuclear energy, and reaching that goal would require the cooperation of the Allied powers, especially the Soviet Union. The two points commanded all the more unity among the Los Alamos generation after Hiroshima, when many of the nation's atomic scientists seemed to regard themselves, in the phrase of *Time*, as the "world's guilty men."[8] Guilty or not, World War II physicists knew, contrary to what various outspoken laymen claimed, that there was no "secret" of the bomb; the laws of nature were available to anyone. Since the technology to exploit those laws could be developed sooner or later by a scientifically capable nation, the current Anglo-American monopoly of the atomic bomb was no guarantee of long-term American security, certainly not against the Soviet Union.

For years scientific visitors to the USSR had all returned with the same report: Russian science was on the march. The second five-year plan had called for considerable investments in research—$200,000,000 a year according to congressional testimony in 1936—and the Russian government paid its physicists well, provided them with well-stocked libraries, ample research facilities, and even rest houses by the sea or in the country. During the war, the Soviet government had maintained a high level of pure research; it had also husbanded its scientific manpower, keeping young men in school and producing, an observer remarked, "a

[7] Quoted in Alice Kimball Smith, *A Peril and a Hope: The Scientists' Movement in America, 1945–1947* (Chicago, 1965), p. 50.

[8] *Time*, 46 (Nov. 5, 1945), 27.

veritable army of young physicists."[9] In mid-June 1945 Soviet planes brought hundreds of foreign scientists, including a dozen Americans, to Russia to celebrate the two-hundred-twentieth anniversary of the Soviet Academy of Sciences. The itinerary included technical conferences and laboratory inspections and climaxed in an enormous banquet in the Great Hall of the Kremlin, where Kalinin, Molotov, and Stalin himself toasted Russian scientists for their contributions to the national defense and designated thirteen of them Heroes of the Socialist Order. Irving Langmuir, a member of the American delegation and not inclined to admire anything Communist, returned home convinced: The Russians would be "capable within a very few years of constructing atomic bombs."[1]

The mushroom clouds had hardly cleared over Hiroshima and Nagasaki before atomic scientists started publicly, passionately, and persistently to plead for the international control of atomic energy. Many of them expected that their Soviet brethren, aware that there could be no adequate defense against nuclear weapons, might help bring about an international accord, and make it work. On the world level, Austin M. Brues, a Manhattan Project veteran, maintained, scientists "see that nationalism means war and nothing else; that wishful thinking along the old pattern can destroy us." Yet now that science was so obviously an instrument of national power, it was even more inseparable than after World War I from the politics of national interest.[2] Most Los Alamos generation scientists tacitly treated it as such. So, quite explicitly, did the leadership of OSRD, in their policy toward former Axis scientists, international scientific affairs generally, and particularly the international control of atomic energy.

Unlike Hale's contemporaries, the leaders of World War II research neither condemned nor sought to ostracize Axis scientists on grounds of war guilt. They may have empathized with the plea of Hugo R. Kruyt, the Dutch president of the successor agency to Hale's ill-fated Inter-

[9] Testimony of Lyman J. Briggs, Subcommittee of the House Committee on Appropriations, *Hearings, Department of Commerce Appropriations Bill for 1937*, 74th Cong., 2d Sess., p. 141; Caryl P. Haskins, "Cooperative Research," *The American Scholar*, 13 (April 1944), 218.

[1] Langmuir to Robert M. Hutchins, Sept. 10, 1945, IL, Box 5.

[2] Brues is quoted in Smith, *A Peril and a Hope*, pp. 180–81. The theologian Reinhold Niebuhr declared: "There is . . . no 'scientific method' which could guarantee that statesmen who must deal with the social and political consequences of atomic energy could arrive at the kind of 'universal mind' which operated in the discovery of atomic energy. Statesmen who deal with this problem will betray 'British,' 'American,' or 'Russian' bias, not because they are less intelligent than the scientists but because they are forced to approach the issue in terms of their responsibility to their respective nations." Niebuhr, "A Faith to Live By . . .," *The Nation*, 164 (Feb. 22, 1947), 204. What Niebuhr said of statesmen tended, of course, to be true of scientists, too.

national Research Council: "keep politics as far from science as possible."[3] But they found their seemingly apolitical posture toward Axis scientists convenient to take, in part because they deemed some of them not guilty. A number of German academics had deeply resented the Nazi perversion of the universities. They and most leading Japanese physicists had contributed nothing to the Axis war machine. Matters of justice aside, the leadership of OSRD was sure, any attempt to suppress basic research in Germany or Japan would provoke a spirit of retaliation and revenge. The national interest of the United States, they insisted, called for encouraging democratically inclined Axis scientists to do basic research, publish their results, and contribute to the economic and political rehabilitation of their countries.[4]

On a more global level, during the war Joseph Needham, the British scientific liaison in Chungking, had proposed the establishment of an international scientific corps to help disseminate, independent of national and commercial interests, advanced scientific knowledge to the less industrialized nations of the East. Anton J. Carlson, the politically liberal president of the American Association for the Advancement of Science, pronounced the scheme "purely wishful thinking," because the great powers, the military services, and even the scientific members of the proposed corps would behave in just as nationalist a fashion as everyone else. Bush, who liked the thrust of the idea, transformed it into a recommendation to FDR for the inclusion of an international scientific section in the charter of the United Nations. The section would, among other duties, police the scientific activities of aggressor nations to the end that no nation should have cause to fear the scientific activities of another.[5] That aim also colored strongly the American plan for the international control of nuclear energy which took shape during the spring of 1946 with contributions of major significance from Bush, Conant, and especially Oppenheimer.

In this program, a world authority established under the United

[3] *The Fourth General Assembly of the International Council of Scientific Unions, Held at London, July 22nd to 24th, 1946, Reports of Proceedings* (Cambridge, England, 1946), p. 3.

[4] *Study of the National Academy of Sciences . . . on the Treatment of German Scientific Research and Engineering from the Standpoint of International Security*, July 2, 1945, OSR, Entry 1, Control of Germany file. Arguing to Bush that German atomic scientists should not be treated as dangerous persons, Oppenheimer declared: "You and I both know that it is not primarily men of science who are dangerous, but the policies of Governments which lead to aggression and to war. You and I both know that if the German scientists are treated as enemies of society, the scientists of this country will soon come to be so regarded." Oppenheimer to Bush, Dec. 11, 1945, *ibid.* The outraged response of Lee DuBridge to the destruction of the Japanese cyclotrons in the fall of 1945 was not atypical. DuBridge, "Recommendation on the Japanese Cyclotrons," [fall 1945], LAD.

[5] Needham, "Memorandum on an International Science Cooperation Service," attached to Needham to Bush, July 25, 1944; A. J. Carlson to Ross T. Harrison, Sept. 25, 1944; Bush to the President, Feb. 22, 1945, OSR, Entry 1, Postwar Planning, Needham Plan.

Nations would eventually control the production and use of all fissionable materials and oversee research and development in atomic energy for peaceful purposes only. But there would have to be a period of transition, Bush and Conant believed, between the signing of the agreement and the full operation of the authority, between 1946, when the United States commanded a nuclear monopoly, and the point in the distant future when no nation would possess a nuclear arsenal. In this transition period, they argued, the agreement would have to go into effect by stages, each accompanied by a quid pro quo from the Soviet Union. On the side of the United States, the stages might proceed from sharing of information about basic nuclear science, then to the release of material concerning the practical, industrial uses of nuclear energy. On the side of the Soviet Union the quid pro quo for each such stage would necessarily be the opening up of Russian basic research laboratories to free, unlimited access by foreign scientists, then acceptance of international inspection of all her nuclear facilities. Only after the inspection system was successfully in force would the United States turn its bombs into power plants.

Whatever the particular stages, Bush, Conant, and Oppenheimer recognized, any international control agreement had from start to finish to protect American security. To that end, Bernard Baruch, whom President Truman appointed to carry the American plan to the United Nations, insisted that the arrangement must include sanctions against violators, sanctions which must not be thwarted in the Security Council. Truman agreed. On June 14, 1946, in a portentous speech, Baruch presented the American plan—the Baruch Plan, it was quickly dubbed—to the newly created United Nations Atomic Energy Commission. "There must be no veto," he stressed, "to protect those who violate their solemn agreements not to develop or use atomic energy for destructive purposes."[6]

Three days later, June 19, Andrei Gromyko declared that the Soviet Union flatly rejected any tampering with the veto power. Otherwise ignoring the Baruch Plan, Gromyko proposed instead an international convention that would ban the bomb, of course meaning the American bomb, almost immediately. Over the next six months, in meetings of scientists and diplomats, the United States and Russia negotiated; the negotiations deadlocked over the issue of the veto. By January 1947 the Baruch Plan was a dead issue.

The veto quarrel doubtless clouded the real reason for the failure of the Baruch Plan. The Soviet Union, keenly aware it was a nonnuclear power, sought to neutralize the American advantage. The Russians preferred either to see the American nuclear arsenal destroyed forthwith, or to develop their own atomic bombs as quickly as possible, or both. Whatever the Soviet reasoning, the United States, its armies swiftly demobilizing, knew that massive Russian forces were poised on the borders of

[6] Quoted in Hewlett and Anderson, *The New World*, p. 578.

eastern Europe. Under such conditions, America would scarcely agree to immediate outlawing of the atomic bomb, the principal deterrent to Russian expansion.[7]

Like Bush and Conant, the Los Alamos generation at large generally endorsed a staged international atomic energy agreement because in the postwar era they emphatically agreed with its premise—that American security had to be protected. As citizens, the majority of atomic scientists read the lessons of the 1930s in the same way as the majority of their fellow Americans: Isolationism was perilous. As scientists, they were particularly sensitive to an argument that had first emerged in response to the repressions of the Nazis, then gathered force during the war. Science, the argument ran, needed freedom to survive, and so did freedom need science. Now, in the immediate postwar years, the Soviet scientific capability not only contributed to the plea for the international control of nuclear energy; it also helped etch deeper the belief that there was another side to the social responsibility of science—that scientists, in the words of Ernest Lawrence's old friend Merle Tuve, had a "definite, irreducible and nontransferable responsibility" to help maintain the national defense.[8]

Like Tuve, the head of the OSRD section that developed the proximity fuze, most of the nation's atomic scientists did not want to fulfill that responsibility as subordinates to the military. They insisted upon a degree of autonomy in peacetime defense research similar to what they had enjoyed under OSRD. But restless under the centralized direction of research, few wanted to remain in anything resembling OSRD itself.[9] While some intended to stay in such civilian-oriented laboratories as Los Alamos, the vast majority preferred to contribute to the national defense from the independent havens of campuses. There they would be free of excessive red tape and unreasonable or, most hoped, any security restrictions. There they could contribute to defense research on a part-time

[7] *Ibid.*, pp. 598, 619; Barton J. Bernstein, "The Quest for Security: American Foreign Policy and International Control of Atomic Energy, 1942–1946," *Journal of American History*, LX (March 1974), 1023–24, 1030, 1032, 1039.

[8] Tuve, "Notes for First Meeting of Committee on Planning for Army and Navy Research," June 22, 1944, and "Addendum to Minutes of Meeting, June 22, 1944," attached to Tuve to Bush, June 27, 1944, OSR, Entry 1, Cooperation: Postwar Military Research Committee.

[9] Bush told a congressional committee that in postwar defense research military officers and civilian scientists "must be equals and independent in authority, prestige, and in funds." U.S. Congress, House, Select Committee on Postwar Military Policy, *Hearings, Surplus Material—Research and Development*, 78th Cong., 2d Sess., Nov. 1944–Jan. 1945, pp. 248–49. Jewett to Bush, Sept. 2, 1943, OSR, Entry 1, Cooperation: Kilgore Committee; Conant, "Science and Society in the Post-War World," *Vital Speeches*, 9 (April 15, 1943), 396–97; Frank Jewett testified in May 1945: "The whole thing is repugnant to the ordinary civilian-life ways of scientists—the restrictions under which they have to operate and the cellular structure. The uniform experience in talking to all of the men who have given a lot of time and effort, to OSRD, is that they want to get out of this thing and get back to their work as soon as possible." *Hearings, Research and Development*, May 1945, p. 58.

basis, through advisory committees or actual research contracts. And there they could foster what virtually all of them considered essential to the maintenance of national security—the training of new scientists and the advancement of science as such.

In James B. Conant's estimate, the war, including the draft, had cost science some 17,000 advanced and 150,000 first degree graduates. The production of scientific doctorates was not expected to reach normal levels again until the mid-1950s. Manpower analysts studied the wartime halt in the prewar growth rates and predicted that by 1953 there would be a deficit of two thousand Ph.D.'s in physics, a sizable figure measured against demands for physicists in industry alone.[1] Besides, the nation was commonly said to have drawn heavily during the war upon its balance in the bank of pure science, and it no longer could expect substantial replenishment from Europe.

In the past, scientific training and research had been paid for by private wealth, but now private wealth, Karl Compton typically re-emphasized, could no longer manage the task. The war effort had given professors the heady taste of doing research with few financial restraints. Typically, the young physicists at the Rad Lab had grown accustomed merely to signing an order for a new instrument whose purchase might have required a major faculty debate before the war. University administrators doubted that able scientists would be satisfied to return to the routine of heavy teaching loads, limited equipment budgets, and low salaries. In the wake of this physicists' war, the Los Alamos generation insisted that if it was the responsibility of the civilian scientist to contribute his expertise to defense research, it was also the responsibility of the federal government to finance the basic research and training on which the nation's security ultimately depended.

During the war the average annual federal investment in scientific research and development had shot up from $48,000,000 to $500,000,000, from 18 percent to 83 percent of the total public and private expenditure for the purpose.[2] The bulk of the increase had naturally gone to the military. Like the leaders of the Los Alamos generation, thoughtful Americans, especially those of a liberal political persuasion, were bothered about the degree to which defense research had come to overshadow basic research and training, and they were bothered by a good deal more in the legacy of wartime science, especially by the specter of monopoly.

Even the probusiness *Fortune* Magazine had concluded that dollar-a-

[1] Vannevar Bush, *Science—The Endless Frontier . . . July 1945* (Washington, D.C.: National Science Foundation, 1960), p. 158.

[2] The President's Scientific Research Board, *Science and Public Policy: A Report to the President, 1947* (5 vols.; Washington, D.C., 1947), I, 10. Part of the material in the rest of this chapter previously appeared in *Isis*, copyright © 1977 by *Isis*, and is reprinted here in different form with the permission of the editor.

year men in the war agencies sometimes rejected the suggestions of small businessmen and inventors for the self-interested purpose of protecting the market positions of their own corporations. Speeches, articles, and advertisements had frequently celebrated, in the language of *Collier's*, "the amazing new world . . . in the making in the plants and laboratories . . . devoted to war."[3] But liberals wondered who would control this amazing new world and its technological marvels. They found disturbing that some 66 percent of wartime contract dollars for research and development went to only sixty-eight corporations, some 40 percent to only ten. OSRD spent about 90 percent of its funds for principal academic contractors at only eight institutions, about 35 percent at the MIT Radiation Laboratory alone. And more than nine out of ten of the contracts from OSRD and the military granted the ownership of the patents deriving from this publicly funded research to the contractors, not to the public.[4]

Critics called the patent practice an unwarranted and dangerous giveaway. Before the war giant American firms had entered into patent agreements with foreign, including German, cartels. These contracts, it was alleged, had kept the United States from developing sufficient supplies of such strategic raw materials as beryllium, magnesium, optical glass, chemicals, and above all, synthetic rubber. Besides, the Temporary National Economic Committee had concluded that big business tended to use the patent system "to control whole industries, to suppress competition, to restrict output, to enhance prices, to suppress inventions, and to discourage inventiveness."[5] Assistant Attorney General Thurman Arnold, the administration's chief trustbuster and a central figure in the wartime patent controversies, explained to a congressional committee: If science and technology were to serve the public interest, it was necessary to do more than just break up patent pools. Something had to be done about the concentrated private control of the underlying knowledge and know-how from which patent pools germinated.[6]

[3] "The Bottleneck in Ideas," *Fortune*, 27 (May 1943), 82–85, 177–86; *Collier's*, 111 (May 8, 1943), 40.

[4] Carroll W. Pursell, Jr., ed., *The Military-Industrial Complex* (New York, 1972), pp. 165, 168–69; James Phinney Baxter, *Scientists Against Time* (Cambridge, Mass., 1968), p. 456.

[5] For salient aspects of the controversy surrounding the relationship between the control of patents and shortages of critical materials, especially synthetic rubber, see *The New York Times*, February 23, 1942, p. 30; March 26, 1942, pp. 1, 16; March 29, 1942, p. 9; April 12, 1942, p. 48; April 15, 1942, pp. 1, 7; April 18, 1942, p. 32. U.S. Senate, *Investigation of Concentration of Economic Power: Final Report and Recommendations of the Temporary National Economic Committee*, 77th Cong., 1st Sess., Sen. Doc. No. 35, 1941, p. 36. Assistant Attorney General Wendell Berge cast doubt on the academic use of patents when he attacked the Wisconsin Alumni Research Foundation for a wide range of abuses in the administration of the Steenbock vitamin D patent. U.S. Senate, Subcommittee of the Committee on Military Affairs, *Hearings, Scientific and Technological Mobilization*, 78th Cong., 1st Sess., 1943, pp. 741–42.

[6] U.S. Senate, Subcommittee of the Committee on Military Affairs, *Hearings, Scientific and Technological Mobilization*, 1943, pp. 11, 25.

In the increasingly powerful Bureau of the Budget, where Director Harold Smith had set a small staff group to work analyzing plans for postwar federal research, young James L. Sundquist pondered the effect of private control upon the public interest in science. In the private sector, if profit was not immediately apparent, Sundquist asserted, new fields of research languished, including smoke control, stream pollution control, low-cost housing, low-cost rural electrification, and the uses of substitute materials. In the governmental sector, established research programs tended to fare better than such new socially purposeful projects. The trouble was, Sundquist argued, that the federal research budget reflected not the "*national need*" but the "national *pressures*" for research. He found the principal pressures arising from economic interest groups and the government's own research agencies.[7] He might have added the increasingly insistent pressures from scientists who were interested in areas of research determined not by social standards of national need but by professional criteria of scientific significance. To balance the emphasis on economically and, now, militarily useful research, liberals like Harold Smith and his staff considered it in the national interest for the government to respond to the mounting demand for federal investment in basic research and training. They also regarded it as equally essential for the government to identify and invest in such areas of research as pollution control for which no pressure groups existed but which would likely pay a high social return.[8]

In the Congress the liberal concern with the control and purpose of national research found a spokesman in Senator Harley M. Kilgore of West Virginia. A small-town lawyer, National Guardsman, Legionnaire, Mason, and past Exalted Ruler of the Elks Lodge, Kilgore was quick to admit "utter, absolute ignorance" of science and technology. The son of a wildcat oil prospector, he was equally quick to discourse on the power of big business, including its power to deprive ordinary people of a fair chance. While a judge of the county criminal court, Kilgore won a reputation for his willingness to help juvenile offenders get a new start. In 1940 the pro-Roosevelt faction in the bitterly divided West Virginia Democratic Party found him a natural, if last-minute, choice for the senatorial nomination. Kilgore squeaked through a three-way primary with less than 40 percent of the vote, winning mainly because of the support of the CIO.[9] Handily elected on FDR's coattails, he went to Washington a down-the-line New Dealer eager to do all he could for the plain folks back home, especially the prolabor folks who had put him into office.

[7] James L. Sundquist to Arnold Miles, Feb. 16, 1945, BOB, series 39.33, file 91.

[8] Smith testimony, U.S. Congress, Senate, Subcommittee of the Committee on Military Affairs, *Hearings on Science Legislation*, 79th Cong., 1st Sess., Oct. 1945, p. 97.

[9] Kilgore, speech, May 10, 1943, copy in OSR, Entry 1, Cooperation: Kilgore Committee; *New York Times*, May 16, 1940, p. 24.

His suits wrinkled, his pockets crammed with papers, pencils, and a good luck horse chestnut, Kilgore soon established himself as an outspoken member of the Truman Committee, decrying the rubber shortage, patent abuses, and the power of dollar-a-year men. In 1942, at the urging of Herbert Schimmel, a congressional staffer who had a Ph.D. in physics, Kilgore introduced a bill for the better mobilization of the nation's technological resources.[1] In the course of extended hearings, Kilgore gradually learned about the critical importance of civilian science to national defense, the concentration of contracts for research and development, the procontractor patent policy of the armed services and OSRD. Moving steadily away from the problems of war mobilization, by the end of 1945 Kilgore had put together a full legislative program for peacetime science.

In Kilgore's program, the federal government was to finance basic research and training in the major fields of science, including a civilian-controlled effort in fundamental defense research. Kilgore called for the evaluation and, in the form of recommendations to the President, planning of all federal research activities to good social purpose. He also urged federal support of the social sciences, insisted that at least part of the money in all fields be distributed on a geographical basis, and proposed that the ownership of patents arising from federally sponsored research normally go to the government. In exceptional cases the contractor might be awarded ownership of the patent, but the government would always receive a royalty-free license for its use. To carry out his program, Kilgore proposed the establishment of a new federal agency, a National Science Foundation, which would of course be a regular part of the executive branch under the direct control of the President.[2]

In a way, Kilgore aimed de facto to extend the social reformism pioneered by John Wesley Powell to virtually the whole of federally sponsored science. In part his program responded to the long-standing demands of public colleges and to the professional self-interest of social scientists; in part it drew upon the preference for national planning of current Budget Bureau staffers, not to mention the pleas in the 1930s of Delano, Merriam, and Mitchell; in part it reflected the issues raised by the wartime mobilization of research. Whatever the roots of its specific elements, Kilgore's package added up to a major liberal initiative for peacetime science.

But while Kilgore's program was evolving, some armed service officers and the National Association of Manufacturers denounced it as a threat to socialize all of science in the United States. Both the army and navy objected to the patent provisions on grounds that they would raise the

[1] Henry H. Collins, Jr. and Herbert Schimmel to Senator Kilgore, Aug. 14, 1942, HMK, file A & M 967, series 1; Schimmel to the author, Oct. 3, 1973.

[2] U.S. Senate, Subcommittee of the Committee on Military Affairs, Report No. 7, *Preliminary Report [on Science Legislation]*, [Dec. 1945], 79th Cong., 1st Sess., copy in OWMR, Box 275, Legislation . . . Scientific Research file.

cost of, if not make impossible, industrial contracts for military research and development.[3] Like their employers, industrial scientists vociferously attacked Kilgore's patent policy, too, but the chief scientific opposition to his overall program came from the leadership of OSRD, especially Vannevar Bush.

Unlike many industrial scientists, Bush endorsed governmental curbs on the domination of markets by large industrial combinations through patents or any other device.[4] He had a variety of proposals in mind to prevent large firms from using the patent system to bar the entry of small firms into lucrative new technological markets; none of his ideas included the measures in Kilgore's program, especially not the stipulation that patents arising from federally sponsored research should belong to the government.[5] To Kilgore's call for the geographical distribution of some fraction of federal research funds, Bush advanced the traditional best-science objection: All the money should be awarded to the best investigators, wherever they were located. Kilgore's proposal to foster the social sciences antagonized the conservative Bush; he did not respect them intellectually and regarded them for the most part as just so much political propaganda masquerading as science. Besides, the OSRD staff worried that their inclusion might place the natural science program in jeopardy. Irvin Stewart, one of Bush's closest aides, advised a dean in Texas: Any provision for the support of the social sciences would be "dynamite."

[3] *Hearings, Scientific and Technological Mobilization*, 1943, pp. 309, 240–41, 245, 271; Walter S. Landis [Vice-President of American Cyanamid Co.], *What's Wrong with the Kilgore Bill* (privately printed, October 1943); *Legislation . . . That Could Radically Change Our Whole Economic Structure* (Commerce and Industry Association of New York, November 1943), copy in HMK, file A & M 967; Julius A. Furer, "Memo for Files," March 26, 1943, and Ralph Bard to Chairman, Senate Committee on Military Affairs, June 2, 1943, NCONR, Kilgore bill file; Harvey H. Bundy to Colonel Ege, April 3, 1943, and attached documents, OSW, Entry 82, Box 73, Technological Mobilization bill.

[4] At the end of World War I Bush's fledgling Raytheon Corporation had almost been forced out of business when General Electric, RCA, Westinghouse, and AT&T formed an exclusive patent pool and marketing agreement for vacuum tubes. In the coming postwar period, he believed, the nation's prosperity would depend to a considerable extent upon the appearance of similar small businesses applying new knowledge in a useful manner. Bush to Oliver E. Buckley, July 25, 1945, OSR, Entry 2, Report to the President, #3; Bush, *Pieces of the Action* (New York, 1970), pp. 198–99.

[5] Bush thought that the government might make it less expensive for small firms to defend a patent by supporting the firm's case in court. The law might also be modified to help small firms to defend themselves against infringement suits by big firms. It would be a valid defense to show that, by exchange of patent rights in combination with others, the big firm had acquired more than a reasonable fraction of the market; if the plaintiff won, he would be awarded only royalties, not an order to cease and desist. Bush was even willing to go so far as to compel the licensing of patents held by large producers who were found to be participants in an exclusive cross-licensing agreement. Bush to Conway P. Coe, November 4, 1943, VB, Box 24, file 567; Bush to John T. Tate, February 8, 1945; Bush to Delos G. Haynes, February 21, 1945; Bush to Robert E. Wilson, March 10, 1945, OSR, Entry 2, Report to the President.

Social scientists could not easily convince Congress to spend federal funds "for studies designed to alleviate [the] conditions of the Negroes in the South or to ascertain the influence of the Catholic Church on the political situation in Massachusetts."[6]

Nothing in Kilgore's program disturbed Bush more than its direct control by the President, especially since the control was to be exercised in conjunction with planning for socially purposeful research. Here was not so much a threat of political interference with intellectual freedom as a prospect of permitting the political system to determine the kind of research to be encouraged. Homer W. Smith, the director of the physiology laboratory at New York University School of Medicine and an adviser to Bush on postwar policy for science, warned: We stand in danger of losing our intellectual heritage "not to personal dictators, anti-scientific prejudices or other antiquated tyrants, but to an as yet unnamed horror of [a] national policy wherein men will be 'requested' . . . to devote their lives to artificial and imposed intellectual interests." Of course, Smith implied, the scientist need not heed the requests, but he would be "forced" to do so through the "pressures of personal and professional financial needs, advancement, security and scientific opportunity." What the scientist required was the opportunity for "free" research, which meant "the intellectual and physical freedom to work on whatever he damned well pleases."[7]

Smith's analysis recalled Alexander Agassiz's assault on John Wesley Powell—and it merited something akin to Powell's response. Without Kilgore's program, were not scientists subject to personal pressures, financial and otherwise? Did they not worry about advancement, security, and scientific opportunity? Did not professional pressures help to determine their research topics? And was not the trend, in other disciplines as well as physics, toward group efforts, in which junior scientists scarcely enjoyed the same latitude as their seniors? Under these circumstances scientists were hardly as "free" as Smith claimed. They were free only from any government encouragement to invest their talents in one field or another. They were free only to operate within a framework defined by private decisions.

Kilgore's program rested on James Sundquist's fundamental assumption: Science had become too important to leave the formation of national scientific policy entirely to the haphazard play of interest groups, scientific or otherwise. Like Kilgore, Bush, too, saw a need for the planning and

[6] Bush to Isaiah Bowman, Jan. 7, 1946, OSR, Entry 1, NSF: Public Interest, Committee for the Bush Report; Bush to D. C. Josephs, Sept. 12, 1946, VB, Box 60, file 1416; U.S. Congress, House, Subcommittee of the Committee on Interstate and Foreign Commerce, *Hearings, National Science Foundation Act*, 79th Cong., 2d Sess., 1946, p. 53; Stewart to A. P. Brogan, Sept. 24, 1945, OSR, Entry 1, Postwar Planning.

[7] Smith to Bush, Aug. 29, 1945, OSR, Entry 1, NSF: Public Interest, Educational Institutions.

evaluation of the national research program. But Bush objected to vesting control over much of the nation's science in a centralized federal bureaucracy, and not without justification. Policy decisions could all too easily favor the bureaucratic over the scientific or even the national interest. Of course, more than in the private arena, public decisions would be open to scrutiny and debate. Nevertheless, while Kilgore aimed to subject the shaping of federal scientific policy to the political process, Bush, a political elitist, wanted the immediate determination of that policy left essentially in private hands, even if its execution involved the expenditure of public funds. "Powerful writing," he exclaimed of Smith's fusillade.[8]

During the fall of 1944, ready to seize the initiative from Kilgore, Bush successfully maneuvered to obtain a letter from FDR requesting a report to the President on postwar policy for science, and in July 1945 he sent the completed document to President Truman under the title *Science—The Endless Frontier*.[9] Like Kilgore, Bush called for a program of federal aid to basic scientific research and training, along with a civilian-controlled effort in fundamental defense research. Unlike the senator, he proposed no remedy for what he acknowledged were "uncertainties" and "abuses" in the patent system, omitted the social sciences from consideration, and made no mention of distributing the funds in his program in accord with either a geographical scheme or the planning of socially purposeful research. Bush conceded that his program had to be responsible—but, in a politically elitist fashion, not responsive—to the President and Congress. Stressing the importance of insulating it from political control, he proposed to operate his program through a new federal agency, which, unlike Kilgore's National Science Foundation, would, in the apt summary of an OSRD staff aide, be "a new social invention—of government sanction and support but professional guidance and administration."[1]

Bush's report, in the remark of an OSRD staff member, was "an instant smash hit."[2] But while applauded in scores of editorials across the partisan and geographical spectrum, it was no smash hit with the *New Republic*, which commented: "Research needs to be coordinated carefully and the projects should be selected in terms of our national necessities, and not the accidental interests of various scientific groups." The politically insular posture of Bush's program was certainly not a smash hit in the

[8] Bush to Carroll L. Wilson, n.d., attached to Smith to Bush, Aug. 29, 1945, *ibid.* To Bush, the primary question was "whether science in this country is going to be supported or whether it is also going to be controlled." Bush to Bernard Baruch, Oct. 24, 1945, OSR, Entry 1, NSF Legislation.

[9] Daniel J. Kevles, "FDR's Science Policy," *Science*, 183 (March 1, 1974), 798–800; Diary of Oscar S. Cox, Oct. 24, 1944, OSC; "News Stories and Editorial Comment on the President's Letter . . .," FDR, OF 4482.

[1] Bush, *Science—The Endless Frontier*, pp. 32–40, 21–22, 38; Laurence K. Frank, "Comments on Bush Report . . .," OSR, Entry 2, Misc.

[2] Lyman Chalkley to Carroll L. Wilson, July 20, 1945, OSR, Entry 2, Distribution; "News Stories and Editorial Comment on the Postwar Program for Scientific Research," OSR, Entry 1, Postwar Planning Reports.

Budget Bureau or with Maury Maverick, the former mayor of San Antonio, Texas, and the head of the Smaller War Plants Administration, who recognized the degree of concentration of defense research contracts and who in October 1945 exploded to a congressional committee: "I get a little tired of these hired hands of the monopolies and some of the professors . . . piously abrogating [sic] to themselves all the patriotism. . . . I'm not sure but that the office holder has been, and is, more conscious of the public welfare than many scientists. . . . Let us all bear in mind that we have a political Government and that our Constitution is a political instrument. The political character of our Government guarantees democracy and freedom, in which the people, through their Government, decide what they want."[3]

At the opening of the atomic age, the revolutionary needs of national security had joined the older requirements of economic development to force an end to what had long been, de facto, a federal policy of laissez-faire in physics. Bush was willing to endorse that end insofar as he was willing to put the government into the business of funding academic scientific research outside of agriculture. But if Kilgore's program was directed at mobilizing scientific research in a fashion politically responsive to the nation's best needs, Bush's aimed to enlist the nation's resources, through a politically elitist mechanism, to satisfy the scientific community's traditional goal of advancing the best science. Like George Ellery Hale at the end of World War I, Bush may have thought that his program disinterestedly sought the apolitical national interest. Set against Kilgore, Bush insisted upon a politically conservative interpretation of what the end of laissez-faire was to mean in postwar America for the Los Alamos generation and its science.

[3] "A National Science Program," *New Republic*, 113 (July 30, 1945), 116; *Hearings on Science Legislation, 1945*, pp. 368–69. In the administratively sensitive Budget Bureau, Harold Smith, who wondered, only half puckishly, whether the "Endless Frontier" implied the "Endless Expenditure," declared most scientists had "learned to accept governmental funds with ease, and . . . they can adapt themselves to governmental organization with equal ease." Smith to Carroll L. Wilson, July 18, 1945, BOB, series 39.27, Box 82, OSRD file; Smith to Julius A. Furer, June 14, 1945, JAF, Research and Development file. Budget staff members found Bush "pompous" and the research policy area filled with "prima donnas." Donald Stone, "Notes Relating to Meeting of Vannevar Bush . . ., Jan. 1945"; Donald Miles to Stone, Feb. 12, 1945, BOB, series 39.32, files E8—21/44.1 and E8–20/45.1.

XXII

Victory for Elitism

For weeks after the end of the war, scientists waited impatiently for a presidential message to Congress on the domestic control of atomic energy. The message finally was delivered on October 3, 1945, accompanying an administration bill. The measure had been drafted in the War Department and it was introduced that day by the chairmen of the two military affairs committees, Congressman Andrew J. May of Kentucky and Senator Edwin C. Johnson of Colorado.

The May-Johnson bill proposed to vest virtually complete authority over nuclear research and development in an Atomic Energy Commission, which, in a politically elitist fashion, was to consist of part-time members appointed by the President but insulated to an extraordinary degree from his removal power. The bill included some weakly worded clauses designed to discourage monopolistic practices in the exploitation of atomic energy by private industry. Beyond that, the measure displayed little concern with the social and economic impact of nuclear fission and it ignored the task of balancing the Commission's program between civilian and military needs. The May-Johnson bill went at the control of nuclear energy more in the manner of Bush, who had suggested a number of its features, than of Kilgore. In tone, and to a degree in substance, it also made the chief object of the nation's nuclear energy program seem to be not the peaceful but the military atom.[1]

[1] Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World, 1939/1946* (*A History of the United States Atomic Energy Commission*, Vol. I; University Park, Pa.: Pennsylvania State University Press, 1962), pp. 412–15, 427–28. Text of the bill, H.R. 4280, 79th Cong., 1st Sess., kindly supplied by Richard G. Hewlett.

In the Truman administration, the implications of the bill were recognized by Don K. Price at the Bureau of the Budget and James R. Newman at the Office of War Mobilization and Reconversion. Price, a Rhodes Scholar and an authority on public administration, was Harold Smith's chief staff man on policy for science. Newman, a product of City College of New York and Columbia Law School, a former counsel for the American Jewish Committee and the Anti-Defamation League, was an irrepressible, outspoken liberal, with a sparkling mind and considerable literacy in science, philosophy, and mathematics. To both Price and Newman, the May-Johnson bill's egregiously independent, part-time Commission flagrantly violated the principle that the President should exercise direct control over all executive agencies. Newman, an enthusiast of Kilgore's program, especially the senator's commitment to planning socially purposeful research, thought that the bill also gave too little emphasis to civilian uses of atomic energy, had too few teeth in its antimonopoly clauses, and left too much of the nation's nuclear future, including its advancement of basic nuclear research, up to the vague good faith of private institutions.[2] Inside the executive branch, Newman and Price launched an offensive for an atomic energy program based on sound principles of public administration and the imaginative adaptation of liberal doctrine to a revolutionary field.

The May-Johnson bill also angered many of the nation's atomic scientists. It seemed to permit domination of the proposed Commission by the military. It also subjected almost all nuclear research in the country to rigid security restrictions, with penalties for violators ranging upward from a fine of $100,000 and a ten-year prison term. To many atomic scientists, the promilitary and security features of the bill threatened to interfere with the conduct of nuclear studies; like every other branch of science, nuclear exploration required a reasonably free flow of information. More important, both features seemed sure to signal to the rest of the world that the United States' primary nuclear interest was in weapons, a posture that would diminish the chances for preventing a nuclear arms race.[3]

These objections were felt most strongly among the rank and file of atomic scientists. The May-Johnson bill was endorsed by Bush, Conant, Lawrence, Fermi, Arthur Compton, and even Oppenheimer. To all save Oppenheimer, who vacillated, the faults of the bill were exaggerated. Bush privately labeled as "absurd" the charge that the measure would lead to military domination of atomic energy. In certain quarters of the Manhattan Project, notably the Metallurgical Laboratory, a conviction that the Franck Report had not been given a full hearing before

[2] Hewlett and Anderson, *The New World*, pp. 437–38.

[3] Alice Kimball Smith, *A Peril and a Hope: The Scientists' Movement in America, 1945–1947* (Chicago, 1965), p. 130.

Hiroshima had already made the wartime administrators of science suspect. Now a number of Project scientists concluded with Herbert Anderson, a highly respected physicist who had been at the Metallurgical Laboratory: "I must confess my confidence in our leaders Oppenheimer, Lawrence, Compton, and Fermi . . . who enjoined us to have faith in them and not influence this legislation, is shaken. . . . Let us beware of any breach of our rights as men and citizens."[4] As men, citizens, and socially responsible scientists, Project veterans like Anderson decided to take legislative matters into their own hands.

In the fall of 1945, scores of atomic scientists descended upon Washington to buttonhole congressmen, lobby within the administration, and educate the public to the necessity for a civilian-controlled program of atomic energy free of unreasonable security restrictions. They started in a single fourth-floor walk-up with a desk, telephone, ancient typewriter, and $20 worth of stationery. Backed by a growing number of study and discussion groups at Project sites and campuses around the country, by early 1946 they formed the active center of the new Federation of American Scientists, with their own magazine, the *Bulletin of the Atomic Scientists*. The leader of the Washington group was thirty-five-year-old William Higinbotham, a physicist who had left his graduate studies at Cornell to join the Rad Lab, then finished the war as an electronics specialist at Los Alamos. Like most of the Washington activists, he was not one of the nation's prominent atomic scientists, but Higinbotham and his young allies, "quiet, modest, lucid and impellingly convincing," in the judgment of the liberal newscaster Raymond Gram Swing, did a good deal to shift influential public opinion against the May-Johnson bill.[5]

In the administration, the scientists' lobby linked up with Price and Newman, who soon added to his program the complete exclusion of the military from the Commission; in the Congress they found a champion in Senator Brien R. McMahon. A former assistant attorney general of the United States, a Democrat and New Dealer, McMahon was a determined freshman from Connecticut. In December 1945 he introduced a bill—it had been drafted by Newman and an associate—for an atomic energy program civilian in control, liberal in purpose, and responsive to the political system. Soon President Truman, who increasingly relied on Newman as his special adviser on atomic energy, shifted to the McMahon bill. In the Congress, many moderates and even conservatives, following the lead of Senator Arthur H. Vandenberg, gathered behind the measure because the field of atomic energy was so new, revolutionary, and fraught with urgent considerations of national security. In July 1946,

[4] Anderson is quoted *ibid.*, p. 140; Bush to Conant, Nov. 4, 1946, VB, Box 27, file 614.

[5] Quoted *ibid.*, p. 171.

after the bill had been modified to give the military a certain—some said significant—voice in the atomic energy program, the McMahon bill passed the Congress with bipartisan support.[6]

The act created a full-time, civilian Atomic Energy Commission, whose members were to be appointed by and responsible to the President. It awarded the Commission complete control over the production, ownership, and use of fissionable materials; it also prohibited the issue of patents for inventions applicable solely in the atomic energy field. Thus rendering atomic energy virtually a state monopoly, the act not only instructed but vigorously equipped the Commission to sponsor pure and applied research in its field, to foster socially as well as militarily purposeful investigations, to encourage competition in the private sector through licensing, and to prevent any industrial corporation from cornering and possibly suppressing a new development threatening to its market position. No less important to most of the nation's scientists, the act enabled the Commission to assure the widespread dissemination of nuclear information, pure and practical, subject to appropriate international agreements and security restrictions which they found acceptable.

In October 1946 President Truman nominated as the first chairman of the Commission David E. Lilienthal, the former head of TVA, who in the course of his confirmation hearings delivered one of the memorable lectures of the day on the relationship between civil liberties and security in a democratic state. The other commissioners included Robert F. Bacher, who had left the Rad Lab to accept an appointment at Los Alamos on the understanding that he would depart the mesa the moment he had to put on a military uniform. If the Atomic Energy Act of 1946 was a victory for civilian control of a singularly important branch of physical research, later critics of the Commission's practices would declare it a triumph for private over public interests. But at the time, in the context of the broader issues in postwar policy for science, Newman could justly call it a victory for a basic principle—"the proposition that the self-regulating mechanism of the market place cannot always be depended upon to produce adequate results in scientific research."[7]

The Atomic Energy Act left most of the vast field of nonnuclear defense research to the armed services, which were eager to follow the dictum of the journal *Army Ordnance*: The maintenance of military superiority in peacetime would require "the marshaling of the best scientific brainpower of our country . . . from our great private research laboratories . . . educational institutions and . . . technical and scientific societies."[8] Armed service planners aimed to enlist civilian scientists as

[6] Hewlett and Anderson, *The New World*, pp. 441–43, 453–55, 489, 502–4, 506, 510–13, 530.

[7] James R. Newman and Byron S. Miller, *The Control of Atomic Energy: A Study of Its Social, Economic, and Political Implications* (New York, 1948), p. 17.

[8] *Army Ordnance*, Nov.–Dec. 1944, p. 485, copy in OSR, Entry 1, Postwar Military Policy Committee.

advisers upon the substance, the conduct, and the strategic implications of military research and development programs. They also intended to continue awarding contracts to industrial and academic laboratories for applied military research. And the more thoughtful planners wondered whether the War and Navy departments ought not to go beyond the nuts-and-bolts development of hardware and help overcome the depletion in the nation's bank account of fundamental scientific knowledge and manpower.

Climaxed by Hiroshima, the miracles of OSRD had driven home to the armed services the military importance of two types of fundamental research. The first was the study of subjects clearly related to military technology, such as the behavior of electromagnetic radiation at the frequencies of microwave radar. The second was the familiar pure science, most commonly exemplified in the discussions of 1945 by the nuclear explorations that had made possible the atomic bomb. The first would contribute directly to the improvement of military technology; either could yield radically new weapons in the future. Conducted on the campuses with the aid of graduate students, both would enlarge the pool of trained scientific manpower. Now, when even Secretary Robert Patterson admitted that the army might have treated draft-eligible scientists too strictly, the armed services strongly endorsed peacetime federal programs outside of atomic energy in both types of fundamental research, but especially in the militarily pertinent kind so obviously in the long-range interest of national defense.[9]

Admiral Furer's wartime staff had included especially keen advocates of such research—a group of bright, imaginative, resourceful young naval officers, most of them Ph.D.'s in science, who acted, in the argot of their outfit, as the admiral's "Bird Dogs," his cocky troubleshooting ambassadors to the naval operating arms. In the middle of the war the Bird Dogs began advancing a plan for a peacetime central office of naval research. Its chief duty in their prospectus was to sponsor, not only in the navy

[9] Early in 1945, the secretaries of war and navy had established a joint military-civilian group in the National Academy of Sciences to carry on a militarily related program of fundamental research when OSRD went out of business. The resort to the Academy was for the interim, until a permanent, peacetime agency could be established. But the interim was no excuse for such an arrangement in the opinion of the Budget Bureau, including Harold Smith, who recognized that under the control of the politically elitist Academy the group would "not be responsible to any part of the Government." At Smith's urging, FDR directed his secretaries of war and navy to withhold all funds and projects from the Academy group. Not long after FDR's death, following a Smith visit to the Oval Office, President Truman reiterated to Stimson and Forrestal that full control of military research and development "must at all times be lodged solely within the framework of the government." Smith to Franklin D. Roosevelt, March 31, 1945; Roosevelt to Bush and Roosevelt to Secretaries of War and Navy, March 31, 1945, FDR, OF 330–8; Truman to Secretary of War, June 8, 1945, attached to Truman to Bush, June 8, 1945, OSR, Entry 1, Cooperation: RBNS; Smith, "Conference with President Truman, June 8, 1945," HDS.

but in the best qualified civilian laboratories, the fundamental research essential for the creation of radically new weapons.[1] The Bird Dogs and their allies got a chance to turn their idea into policy when they became part of a new research office that Secretary Forrestal, acting under his temporary war powers, created in May 1945. In 1946 Congress made the agency permanent as the Office of Naval Research, or ONR.

The new Office was headed by Admiral Harold G. Bowen, the forceful head of the Naval Research Laboratory. Bowen was no friend of the regular bureaus; they had banished him to the Research Laboratory, a kind of purgatory in the prewar years, after he fought to introduce the use of superheated steam. Now Bowen wanted to push the development of a nuclear-powered navy. He was also still smarting at the high-handed and supercilious way that the OSRD hierarchy had treated the navy's scientific arms during the war, and smarting all the more now that the Rad Lab was getting all the credit for wartime radar. Bowen found congenial to his own predilections the Bird Dogs' advocacy of a program of fundamental naval research conducted independently of the bureaus. And he was ready to carry out the program with zeal. The zeal possibly reflected an eagerness to enlist academic physicists in his drive for nuclear-powered ships.[2] It almost certainly revealed a determination to show that his part of the navy could manage civilian scientific research at least as well as Bush and OSRD.

In the fall of 1945 Bowen and his staff traveled around the country with promises of research funds and promptly raised suspicions among academic scientists. Would not military support involve irritating red tape, crippling security restrictions, and projects of primarily military, not scientific, interest? But Bowen's Office minimized the red tape and allowed university scientists virtually complete freedom in the conduct and publication of their research. Equally important, Bowen's Office funded not only militarily relevant but even pure research projects. It also left the initiative for proposing the projects up to the academics. The navy chose which projects to support with the help of a cadre of civilian scientific advisers, whose members included Warren Weaver as chairman, Lee A. DuBridge, and the Compton brothers.[3]

[1] The Bird Dogs [Bruce S. Old et al.], "The Evolution of the Office of Naval Research," *Physics Today*, 14 (August 1961), 32; R. D. Conrad to Coordinator of Research and Development, Sept. 3, 1943, OSR, Entry 1, Postwar Planning; Bruce S. Old, Ralph A. Krause, and John T. Burwell to Secretary of the Navy, Sept. 23, 1944, NCONR, Postwar Research file, Vol. IV.

[2] Bowen to Burt Nanus, April 8, 1959, copy kindly supplied by Edward L. Bowles; Lewis Strauss to Secretary of the Navy, May 25, 1945, JFN, file 39-1-8; Furer Diary, May 29, 1945, June 4, 1945, JAF; Harvey M. Sapolsky, "The Origins of the Office of Naval Research," chapter two, *ONR: Science and the Navy* (in preparation).

[3] John E. Pfeiffer, "The Office of Naval Research," *Scientific American*, 180 (Feb. 1949), 12-13; The Bird Dogs, "The Evolution of the Office of Naval Research," p. 35.

In February 1946 Bowen's staff announced that they had negotiated contracts with forty-five schools and industrial firms; by August 1946, when the bill establishing ONR was signed into law, Bowen already had in force 177 contracts, totaling $24,000,000, with eighty-one universities or private and industrial laboratories. ONR was supporting more than 602 academic research projects, which together involved some two thousand scientists and an equal number of graduate students. It was building cyclotrons and betatrons, signing up astronomers, chemists, physiologists, botanists, branching out into such unmilitary studies as meteors, the rare earths, and plant cells.[4]

Yet at least some scientists worried with Harlow Shapley, the prominent Harvard astronomer and political activist, who declared: The government's "intercession in American science . . . has altered, and perhaps become ominous . . . because of the Navy's great move in supporting science on a wide basis. . . . Those who were worried about domination of freedom in American science by the great industries, can now worry about domination by the military."[5] ONR may have permitted scientists to pursue and publish what they wanted, but it did decide what to support in part on criteria of utility to the navy. In any case, the degree of scientific freedom allowed by Bowen's operation was scarcely the whole issue. Earlier, Admiral Furer had argued that naval support of civilian research would win the service a cadre of distinguished scientists who would act as "ambassadors of national preparedness" in the civilian scientific community. Now, the army chief of staff for research and development observed, the military was said to be making "prisoners of war" of the nation's scientists.[6] Whatever Furer's enthusiasm, such overwhelmingly military patronage of academic science —the Office of Naval Research accounted for three out of four of all federal dollars spent for such fundamental research—scarcely made for sound public policy. It might produce fine science, but it threatened to bind too many of the nation's scientists to the military's purposes and bureaucratic self-interest.

The military domination of academic science was a matter of some

[4] *Newsweek*, 27 (Feb. 11, 1946), 89; Bowen to the Secretary of the Navy, Aug. 30, 1946, HGB, Box 2; Karl T. Compton to John R. Steelman, Oct. 23, 1947, attached to Karl T. Compton to James Webb, Oct. 27, 1947, VB, Box 26, Karl T. Compton file.

[5] Harlow Shapley to Isaiah Bowman, Nov. 6, 1946, VB, Box 13, Bowman file. Louis N. Ridenour, Albert Einstein, Philip Morrison, et al., "Military Support of American Science, A Danger?" *Bulletin of the Atomic Scientists*, 3 (Aug. 1947), 221–30. Henry Wallace declared the military were "going far beyond their legitimate concern—the development of weapons in accord with our defense needs—and thus unconsciously and without intent crippling science and corrupting scientists." Wallace, "Science and the Military," *New Republic*, 116 (Feb. 3, 1947), 26.

[6] Naval Coordinator [Furer] to All Bureaus and Offices, Feb. 23, 1945, JFN, file 39-1-8; Major General H. S. Aurand to the Secretary of War, WDGS, Legislative and Liaison Division, Bill File S. 1850.

concern in the Bureau of the Budget, which had approved the entrance of Bowen's office into the large-scale support of fundamental research only as an interim arrangement. The navy had agreed that, once the National Science Foundation was created, the bulk of the pure and even some of the militarily related research projects of ONR would be turned over to the new agency, where they belonged.[7] In the Budget Bureau and among thoughtful members of the scientific community, the way to halt the increasing military role in academic science was for Congress to create the foundation as soon as possible.

Early in the summer of 1945, to advance his version of such a foundation, Bush had a bill drafted in OSRD and introduced by Senator Warren G. Magnuson of Washington, a freshman New Deal Democrat. At hearings on the Kilgore and Magnuson bills in the fall, all ninety-nine witnesses save one—Frank B. Jewett—endorsed the creation of a single federal agency that would award grants, contracts, and fellowships to sponsor training and fundamental research, including militarily relevant research, in all fields of the natural sciences. But there was no such consensus about the key issues dividing Kilgore and Bush: planning, social sciences, geographical distribution, patents, and, above all, the degree of programmatic control by the President. The issue of presidential control, which drew the most attention at the hearings, found specific expression in a dispute over the proposed foundation's administrative structure. In Kilgore's politically responsive scheme, the foundation was to be managed by a director appointed by and responsible to the President. In Bush's politically elitist approach, the foundation was to be governed by a presidentially appointed part-time board of private citizens, mainly scientists, who would choose a director responsible not to the President but to themselves.

To Don K. Price and James R. Newman, the dispute over the foundation raised much the same issues as the battle over atomic energy. Together with Harold Smith they formed a coalition against Bush with considerable influence in the White House, and in the President's first postwar legislative message, paragraphs written by Newman made Kilgore's general program the program of the Truman administration. Kilgore, who faced an election in the fall of 1946, seemed to want a passable bill. Early in 1946 he introduced a revised measure—it was

[7] Blessed with an abundance of military funds, colleges were rapidly building research groups and laboratories, a Budget staff member noted. "Several years from now the military budgets may be cut sufficiently so that the military cannot afford to support so much basic research. . . . When this time arises the colleges will be faced with the unpleasant dilemma of finding other sources of funds, firing some of their staff, and closing down laboratories, or accepting applied research on weapons with the necessary security restrictions." Unsigned memorandum, n.d. [April 1947], BOB, series 39.33, file 93; W. L. Clark III to Director, Planning Division, Office of Naval Research, May 29, 1946, ONR, Planning Division file.

designated S. 1850—which compromised on details but maintained his program's social purposefulness and degree of presidential control.[8] In July, S. 1850, intact save for its social science clause—the social sciences, it was contended on the floor, were merely elaborate ways by which some people told many others how to behave, especially in politics—passed the Senate.[9] But in the House, the young Arkansas Congressman Wilbur D. Mills had introduced a bill along the lines of the original Bush program. Anxious to get home to campaign for reelection, Mills and his colleagues declared themselves unable to resolve the complex differences between the Mills bill and S. 1850. The foundation failed in the 79th Congress.

When the Republican-dominated 80th Congress convened in January 1947, leadership for a foundation bill was assigned to Senator H. Alexander Smith of New Jersey. A first-term senator in his mid-sixties, Smith was a Princeton graduate and an acolyte of Woodrow Wilson in international affairs, a successful corporation lawyer and devotee of his alma mater—in the 1920s he interrupted his legal career to be secretary of the university—a conservative Republican disposed to sympathize with the views of professors from private colleges in the East, including the politically elitist, best-science views of Vannevar Bush.[1] Smith drew up a new bill that closely followed Bush's approach on key points, including geographical distribution and insulation from presidential control. In the summer of 1947, despite objections of senators from scientifically have-not states, Congress passed the Smith measure. But President Truman vetoed the bill, explaining that he could not approve the establishment of an executive agency so far beyond the control of the nation's chief executive.[2]

The veto message emphasized that the President would gladly sign into law an act establishing a science foundation subject to the President's

[8] J. R. Newman and M. E. Doyle to Fred Vinson, June 26, 1945, OWMR, Box 277, Research Board for National Security file; "Special Message to the Congress . . . Sept. 6, 1945," *Public Papers of . . . Harry S Truman, 1945*, pp. 292–94; copy of S. 1850 in OWMR, Box 275, Legislation . . . Scientific Research file.

[9] U.S. Congress, Senate, *Congressional Record*, 79th Cong., 2d Sess., July 1, 1946, p. 8048; Kenneth M. Jones, "Science, Scientists, and Americans: Images of Science and the Formation of Federal Science Policy, 1945–1950" (unpublished Ph.D. dissertation, History, Cornell University, 1975), p. 325.

[1] Arguing in 1946 for a foundation insulated from the President's control, Senator Smith had claimed that scientists were "not at all controlled by the consideration of who pays them the money, whether it comes from the Government, or whether it comes from private sources. They are inspired by their interest in the subject, by their dedication to the pursuit of knowledge." U.S. Congress, Senate, *Congressional Record*, July 2, 1946, p. 8113.

[2] It is interesting to note that Senator Wayne Morse of Oregon, who had urged the Senate, unsuccessfully, to incorporate a clause mandating at least some geographical distribution of the funds, urged Truman to veto the bill, which, he asserted, was "fostered by monopolistic interests" and was opposed by "a great many educators and scientists associated with state-supported educational institutions." Morse to Truman, HST, OF 192–3. It is also interesting to note that the chief of the Senate Majority Policy Committee staff had predicted that the President would never veto the bill. George H. E. Smith to H. Alexander Smith, April 24, 1947, HAS, Box 132, NSF file.

direct control. But though a compromise to meet that stipulation passed the Senate, Robert Taft had said that no bill creating such a foundation would pass the 80th Congress, not if he had anything to say about it.[3] None did.

When the Democratically controlled 81st Congress convened in January 1949, the Senate quickly passed the same compromise bill, only to have it bottled up in the House Rules Committee by a coalition of Republicans and Southern Democrats. Relentlessly economy-minded, they argued: why spend additional money for scientific research when the armed services were already funding all the research they needed?[4] The bill remained in the Rules Committee until February 1950, when the House leadership extracted it by a parliamentary maneuver. In March finally, the Congress passed and the President signed the act establishing the National Science Foundation.

The act of 1950 was considerably watered down from the S. 1850 of 1946. Like S. 1850, it made the director of the Foundation a presidential appointee and included a mandate for planning the overall federal research program. Unlike S. 1850, it omitted any specific scheme for geographical distribution and made no change in the wartime policy for patents arising out of federally financed research and development. While S. 1850 had authorized the Foundation to conduct militarily related basic research, the 1950 act left the control of all such research to the armed services. As created, the Foundation was to pursue primarily pure research and training. At last, Lee DuBridge, now the president of the California Institute of Technology, optimistically cheered, there was an agency to "free basic science from the danger of becoming a stepchild of military technology."[5] But if the Foundation had been originally conceived as the government's chief sponsor of fundamental research, in 1950 it was only a puny partner in an institutionally pluralist federal research establishment.

In 1949 the Public Health Service, the Defense Department, and the Atomic Energy Commission together spent more than $63,000,000 on the campuses for applied and fundamental research.[6] The National Science

[3] Paul Scherer to Bush, attached to John Teeter to Bush, Aug. 29, 1947, VB, Box 110, Teeter file; U.S. Congress, Senate, *Congressional Record*, 80th Cong., 2d Sess., May 3, 1948, pp. 5178, 5182–83.

[4] Robert P. McCune, "Origins and Development of the National Science Foundation and Its Division of Social Sciences, 1945–1961" (unpublished Ph.D. dissertation, Education, Ball State University, 1971), pp. 146–48; William D. Carey to Elmer Staats, Aug. 18, 1949, BOB, series 39.32, file E8–21/49.1.

[5] Quoted in McCune, "Origins of the National Science Foundation," p. 156.

[6] Stephen P. Strickland, *Politics, Science, and Dread Disease: A Short History of United States Medical Research Policies* (Cambridge, Mass., 1972), pp. 32–54; Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947/1952* (*A History of the United States Atomic Energy Commission*, Vol. II; University Park, Pa.: Pennsylvania State University Press, 1969), pp. 80, 82–83, 108–9, 111–12, 255–59; "Federal Research and Development Activities at Colleges and Universities," July 17, 1950, BOB, series 47.8a, Research and Development, College and University file.

Foundation, limited by its organic act to a ceiling of $15,000,000 in any one year, was struggling along on a piddling appropriation of $350,000. Budget Bureau planners may have expected the Foundation to be the chief federal sponsor of basic research, but the Public Health Service successfully fought to keep its rapidly growing programs of such research in medicine. Although at least one-third of Office of Naval Research dollars were spent on pure research projects only remotely related to naval purposes, ONR had reneged on its agreement to cede any of its fundamental research, militarily relevant or even pure, to the new Foundation.[7] Unless the navy was in direct contact with the men actually conducting basic research, Secretary Forrestal argued to a congressman, the fleet and air arms could not remain abreast of current scientific discoveries. In 1949 the Defense Department together with the Atomic Energy Commission accounted for 96 percent of all federal dollars spent on the campuses for research in the physical sciences. For every two of those dollars spent by the AEC, the military spent at least three.[8]

Of course the military enjoyed considerable power because of the mounting Cold War concern with national security. Military requirements compelled even the civilian Atomic Energy Commission to stress research and development for weapons, notably the hydrogen bomb. But the AEC never permitted itself to become a mere nuclear weapons contractor for the Department of Defense. By virtue of its mandate and its civilian control, it could and did maintain an ongoing investment in the peaceful uses of atomic energy, including the development of nuclear power; late in 1951, at an AEC laboratory, a nuclear reactor first transformed atomic power into 45 kilowatts of electrical energy.[9] In the absence of a National Science Foundation between 1945 and 1950, no comparable institutional sponsor of fundamental physical research for civilian needs had existed, nor had any comparable institutional mechanism to plan, if not to enforce, a research program in the physical sciences better balanced between civilian and military purposes.

Once created, the Foundation was legally authorized to slip an evaluative check rein over agency research programs, but the defense agencies were determined to resist such judgment. Their opposition was not lost upon the first director of the Foundation, the physicist Alan Waterman, a student and protégé of Karl Compton's, a member of the Yale faculty, and a wartime veteran of the OSRD Office of Field Services. Shortly

[7] William D. Carey to Elmer Staats, May 10, 1950, July 17, 1950, BOB, series 39.33, unit 95; series 39.32, file E8–33/44.2; R. C. Atkinson, "Memorandum of Conference with Willis Shapley," July 12, 1950, BOB, series 39.32, file E8–20/48.1; Shapley to Ramsey, Aug. 8, 1950, BOB, series 39.33, unit 91.

[8] Forrestal to Charles A. Wolverton, March 7, 1947, HAS, Box 132, NSF file; "Federal Research and Development Activities at Colleges and Universities," July 1, 1950, BOB, series 47.8a, Research and Development, College and University file.

[9] Hewlett and Duncan, *Atomic Shield*, pp. 31–32, 182, 411, 498.

after the Japanese surrender, Waterman was appointed chief scientist at the Office of Naval Research. He was deliberate, firm, modest, patient, and above all prudent. He consistently opposed the transfer of most of the military's fundamental research programs to the National Science Foundation before its creation. Now, after its establishment, he proposed to ignore the Foundation's mandate for planning. Along with considering any centralized evaluation of federal research impossible and inappropriate, he was also worried about pitting his infant, penurious, and decidedly vulnerable agency against such giants as the Department of Defense.[1]

Perhaps under the circumstances Waterman was wise to avoid taking on the defense research agencies. Whatever the merits of his judgment, the task of planning and evaluation was certainly much more difficult in 1950 than it would have been in 1946, when even the armed services had been willing to concede the primary sponsorship of fundamental research to civilian hands. In retrospect, the delay in the establishment of the National Science Foundation was critically important in the evolution of postwar policy for research and development, not least because it cost the nation a program balanced between civilian and military patronage and purpose.

James B. Conant, who from the beginning worried about the increasingly military patronage of American science, later blamed the delay in the passage of the bill for a National Science Foundation upon President Truman, mainly for his 1947 veto.[2] Conant might have enlarged his reckoning of responsibility to include the congressional conservatives who blocked the passage of the bill before as well as after the veto and who in 1947, persuaded by Senator Taft's declaration that he would prefer no foundation at all to one under the President's control, sent the White House a politically elitist measure. True enough, in 1946 the

[1] Carey to Staats, Feb. 24, 1950; James L. Grahl to files, April 3, 1951, BOB, series 39.33, unit 94 and file 93; Milton Lomask, *A Minor Miracle: An Informal History of the National Science Foundation* (Washington, D.C., 1976), pp. 72–73, 83. After the Korean War broke out, the defense research agencies demanded still higher —some observers thought exorbitantly higher—funding. In the Bureau of the Budget William D. Carey watched the trend apprehensively. One day in the spring of 1952, Carey went over to the Foundation's headquarters on California Street in Washington—"a rambling old house with a ripe brick exterior and a kind of mouldy antiquity," he described it—to prod Waterman into making active use of his planning mandate. He found Waterman running the Foundation like "a dean of studies" in "an atmosphere of unhurried deliberateness, and good if not fashionable living." The Foundation was "settling down cozily with the Defense Department . . . in joint planning activities. . . . Waterman's idea is to operate on the basis of the scientist-to-scientist approach. . . . Out of this spiritual communion will emerge gentlemen's agreements leading to the formation of spheres of influence for research sponsorship." Carey to Staats, May 15, 1952, BOB, series 39.33, file 93.

[2] James B. Conant, "An Old Man Looks Back, Science and the Federal Government: 1945–1950," *Bulletin of the New York Academy of Medicine*, 47 (1971), 1248; *New York Times*, Jan. 9, 1971, p. 13.

President scarcely threw the full weight of his office behind the passage of S. 1850, and afterward he displayed much less concern with the substance of the program than with its control. But while in 1947 his advisers in the Budget Bureau understood that the veto might prolong indefinitely the military ascendancy over academic science, they also agreed with Don K. Price, by then at the Public Administration Clearing House in Chicago, who argued in a special memorandum that the President must veto the bill. Along with giving control over a federal granting agency to people who would be getting the grants, Price pointed out, the measure would improperly vest the responsibility for planning an overall federal science program in officials largely beyond the reach of presidential power.

Price's analysis called up much the same objections that Secretary David Houston had advanced a quarter of a century before against George Ellery Hale's proposed executive order for the National Research Council. Yet if in key respects the issues were similar, in the post-World War II context, the stakes were much higher—"the safeguarding," in Price's phrase, "of the public's interest in [science]." So long as the choice was posed between a politically elitist and a politically responsive system, the President, who based his veto message on Price's memorandum, opted for letting the military remain the principal patron of basic research in the physical sciences.[3]

No single individual did more to keep the choice framed between those two alternatives than Vannevar Bush. Few scientists were better placed to affect policy than Bush, who remained in Washington as head of the Carnegie Institution and who headed the successor to the Joint New Weapons Committee in the defense establishment. No administrator of science was said to know better than Bush how to call forth the best efforts of the nation's scientific talent or to organize scientific research. No one save Oppenheimer, who was preoccupied with atomic energy policy, commanded more respect in congressional circles and among the public at large. With all his authority and prestige Bush—in the angry view of James R. Newman—systematically "sabotaged" the President's program for science.[4]

In the fall of 1945, even after the President had endorsed the main lines of Kilgore's program and Harold Smith had spelled out the President's policy to Bush in a special letter, Bush still testified for the Magnuson bill. To help advance the bill, he even supplied Magnuson with the services of John H. Teeter, an engineer and technical aide on the

[3] "D. K. Price's Memo on the National Science Foundation," BOB, series 39.33, file 93; James E. Webb to Mr. Latta, Aug. 1, 1947, HST, bill file (S. 526); Truman, "Memorandum of Disapproval," Aug. 6, 1947, BOB, series 39.32, file E8-33/44.2.

[4] Newman to Hans Klagsbrunn, Dec. 14, 1945, OWMR, Entry 16, Legislation Scientific.

OSRD payroll. A former student and then colleague of Bush's at MIT before going off to industry, Teeter was the kind of conservative who often confused liberalism with socialism, a political novice tending to approach congressional politics with a conspiratorial air. He tirelessly advocated Bush's program and kept a watchful eye on the Kilgore forces, whose real aim, he was sure, was to subject science to basely political control. It was Teeter who induced Congressman Wilbur Mills to introduce his pro-Bush measure in the House.[5] In the spring of 1946, despite broad academic and scientific support for the compromise S. 1850, Bush urged Senate Republicans to amend the measure back to his original program and endorsed the Mills bill in public hearings. Howard A. Meyerhoff, professor of geology at Smith College, a liberal advocate of S. 1850 and the secretary of the American Association for the Advancement of Science, bluntly pronounced the death of the Senate compromise a "homicide" committed by Bush and Teeter.[6]

From the beginning of the battle through the veto, Bush behaved with an unusual degree of independence for a presidentially appointed federal official. Admonished by Don K. Price and Harold Smith to get in harness with the President, Bush queried Truman: Should I consider myself a member of the official family bound not to speak publicly against administration policy? Consider yourself a member of the official family, Truman shot back, so long as you are head of OSRD.[7]

If Bush persistently violated the President's wish, his friends claimed that he was only acting as a private citizen. The claim had its merit, since Bush remained head of OSRD only to wind up its affairs and was not drawing a government salary in his defense post. Besides, save on some atomic energy matters, the President and his advisers did not consult Bush about policy for science; under Truman, in contrast to Franklin Roosevelt, Bush was far from the center of White House power. His postwar exclusion from the orbit of the Oval Office rankled. Conant

[5] Smith to Bush, Oct. 1, 1945, Entry 1, NSF Hearings; Smith, "Daily Record," Oct. 15, 1945, HDS; Teeter to Ruebhausen et al., Oct. 8, 1945, OSR, Entry 1, NSF, Inter-Office Memoranda; Teeter to Ruebhausen, June 4, 1946; Teeter to Peter Edson, June 4, 1946, OSR, Entry 1, NSF Legislation.

[6] Bush to Conant, June 19, 1946, OSR, Entry 1, NSF Legislation; Meyerhoff, "Obituary: National Science Foundation 1946," *Science*, 104 (Aug. 2, 1946), 97. In June 1946, Teeter brought Father Hugh O'Donnell, the president of Notre Dame and a contributor to *Science—The Endless Frontier*, to the House of Representatives for lunch. "The entrance into the House dining room was like high mass," Teeter reported to Bush. "Every man we needed to see came to the table . . . and Father O'Donnell sold each one on the [Mills] bill and on a militant attitude towards communists." Teeter to Bush, June 10, 1946, OSR, Entry 1, NSF Legislation.

[7] Contrary to prevailing canons of practice, Bush had Magnuson introduce his bill without first asking the Budget Bureau whether it was in accord with the President's program. Bush to Truman, Oct. 13, 1945; Truman to Bush, Oct. 19, 1945, HST, OF53; Newman to Snyder, Dec. 4, 1945, OWMR, Entry 16, Legislation Scientific.

believed, according to Teeter's report, that the National Science Foundation was "V.B.'s baby," that Bush approached the issue as a "personal matter, with much personal feeling."[8]

Still, Bush was convinced that the National Science Foundation could—and should—be kept safely insulated from political accountability. No one need worry, he told President Truman, that the Foundation's distinguished governing board of private citizens, many of them accomplished scientists, would act improperly in awarding grant money; it would make no difference that they might come from the institutions receiving the grants.[9] With equal ingenuousness, Bush expected to prevent the military from dominating academic science. Like the Bureau of the Budget, he backed the navy's support of research in the universities only as a temporary measure. Bush acknowledged that the armed services, having entered the field of basic research, seemed to want to stay in it. But he was "not at all fearful on this matter." Bush assumed that Secretaries Patterson and Forrestal undoubtedly saw the inappropriateness of permanent military patronage in the same disinterested way as himself. And when the time came, Congress would surely recognize how "quite unreasonable" it would be to continue funneling federal money into academic science primarily through the armed services.[1]

Bush failed to win the battle over atomic energy legislation because most atomic scientists contested him with single-minded vigor. They engaged in no comparable campaign for Kilgore's program, or even, the more time passed, for the speedy creation of any kind of National Science Foundation. Physical scientists who had worried about military domination in the atomic energy program in 1945 worried about it much less in physics generally after the armed services, especially ONR, proved that they would fund science tolerantly and richly. In 1948 nearly 80 percent of the papers presented at the American Physical Society meetings were said to have been supported by Office of Naval Research

[8] Teeter to Ruebhausen et al., Oct. 8, 1945, OSR, Entry 1, NSF Inter-Office Memoranda. In 1947 Bush complained to the President that when Franklin Roosevelt had wanted a report on science policy, he had called in Vannevar Bush; when Harry Truman wanted one, he gave the responsibility to Presidential Assistant John R. Steelman. Remaining outside of presidential favor, Bush also lost the support of Secretary of Defense Forrestal while chairman of the Research and Development Board in the Defense Department. Evidently frustrated at his powerlessness, Bush developed severe psychosomatic headaches, which were first diagnosed as a brain tumor. His physician told him to get out of the government, which Bush did, never to return, and the headaches went away. Bush, *Pieces of the Action* (New York, 1970), p. 303; Bush, "Memorandum of Conference with the President on Sept. 24 [1947]," VB, Box 112, file 2675; transcript of Eric Hodgins interview with Bush, 1966, pp. 179A–183, VBM.

[9] Bush to Conant, Oct. 20, 1945, VB, Box 27, file 614; "Memorandum of Conference with the President on Sept. 24 [1947]," VB, Box 112, file 2675.

[1] Bush to Ruebhausen, Sept. 27, 1946, VB, Box 100, file 2309; Bush to Forrestal, Dec. 11, 1946, VB, Box 85, NSF file.

money. In 1949 ONR paid for more than eleven hundred projects at more than two hundred institutions, at a cost of $29,000,000. About three out of every four of these navy research dollars went to the physical sciences—and to the scientists who in the wake of Hiroshima enjoyed the most public standing and political leverage. Even Bush noted that American scientists were decidedly happy with ONR, happy enough, possibly, not to mind the absence of a National Science Foundation.[2]

In the contest over atomic energy legislation the scientific community was united in its opposition to Bush, and its members displayed relatively little interest in patents, social impact, or the politically elitist nature of the May-Johnson proposal. In the dispute over the National Science Foundation program, the nation's atomic scientists were either neutral or divided with respect to such issues as patents or the social sciences. More important, whatever views physical scientists held on those matters, like Harlow Shapley most tended to share in greater or lesser degree Bush's predilection for a National Science Foundation insulated from political control. And in the postwar years their traditional concern for freedom in science was strengthened by the memory of Hitler's oppression, not to mention the current specter of Stalinism.[3]

In the final legislative compromise, the nation's scientists won a victory for political elitism. As they conceded it had to after 1947, the law empowered the President to appoint the director of the National Science Foundation, but it also provided for the director to share control of policy with Bush's part-time private board. For the most part, the members of the first board were spokesmen for the nation's leading institutions of academic and industrial science. When the board first met early in 1951, it declared that the principal function of the Foundation was to advance basic scientific research and training, and that alone. It soon also endorsed Waterman's determination to avoid the tangled

[2] John E. Pfeiffer, "The Office of Naval Research," *Scientific American*, 180 (Feb. 1949), 11, 14; Bush to Ruebhausen, Sept. 27, 1946, VB, Box 100, file 2309. *Business Week* noted in 1946 apropos the effect on the prospects of a National Science Foundation of massive military support of basic science: "Even though many scientists deplore the warping of the direction of research inevitable in a military program, some of the university people—with their fields well established, their file of telephone numbers organized, and the money flowing freely—may hesitate to upset a going operation." *Business Week*, Sept. 14, 1946, p. 24.

[3] Shapley's Committee for a National Science Foundation went no further on the control issue than to call for a compromise on the question of a board vs. a single administrator. Committee press release, Dec. 28, 1945, OWMR, Box 275, Legislation . . . Scientific. Shapley himself was willing to go along with a division of responsibility between a part-time board and a presidentially appointed administrator. While an Inter-Society Committee for a Foundation opted for a presidentially controlled agency, the vast majority of its members were drawn from the affiliated scientific societies of the American Association for the Advancement of Science, most of which were in the life and social sciences. Fred D. Schuldt to Carey, Dec. 5, 1947, BOB, series 39.33, file 93; Lomask, *A Minor Miracle*, pp. 52–53.

thickets of evaluation and planning in federal research. On his part, Waterman, who had advocated Bush's politically elitist approach to the control of the Foundation, deferred to the board on all major policy issues.[4]

Waterman and his board agreed in particular on the key policy point of how to distribute the Foundation's funds. While the final law called upon the Foundation to help advance science in the scientifically underdeveloped regions of the country, the governors of the Foundation generally ignored the injunction, in part because their funds were limited, but, more important, because, like Bush, they were strongly disposed to a best-science approach.[5] So were most other managers of federal programs for research and development that relied on academic and industrial laboratories. Though paying some attention to spreading their largess around the country, the Office of Naval Research and the Atomic Energy Commission tended to award their contracts to the people most qualified to pursue the required research, which meant in a distributional pattern concentrated among the leading institutions of scientific research.[6]

In 1945 liberals like Kilgore may have wanted a federal program balanced between civilian and military needs, between big business and small business, between the leading and the less developed universities, between the welfare of science and the welfare of the nation. By the early 1950s the outcome was quite different: a program for the physical sciences dominated outside of atomic energy by the military, its dispensations concentrated geographically in the major universities, its primary energies devoted to the chief challenges of national defense and fundamental physics. While the Cold War had made such an outcome possible, the result was produced not by design but by a combination of demands and defaults, including the demands and defaults of a new political power group, the nation's physical scientists. Whatever the cause of the outcome, it constituted a revolution in the relationship of American physicists to

[4] The vice-chairman was the biochemist Detlev W. Bronk, the new president of the Johns Hopkins University, Jewett's successor as head of the National Academy of Sciences, and a forceful advocate of Bush's views. The chairman was Conant, who had defended Bush's program and attacked Kilgore's: "There is only one proven method of assisting the advancement of pure science,—that of picking men of genius, backing them heavily and leaving them *to direct themselves*." Conant to the Editor, *New York Times*, Aug. 3, 1945 [published Aug. 10], OSR, Entry 2, President's Letter, Nov. 17, 1944; Lomask, *A Minor Miracle*, pp. 72–73; Schuldt for files, Dec. 18, 1950; National Science Board, press release, Feb. 15, 1951, BOB, series 39.33, unit 94.

[5] The clause was the work of William D. Carey in the Budget Bureau. Eager to temper Bush's best-science propensity for "putting the money where it will produce the most efficient research," Carey had argued that the Foundation should not only be instructed to avoid the geographical concentration of its largess; it should also be told actively to broaden "the research base of the Nation instead of feeding the 'fat cats' who are most likely to come up with the best answers." Carey to Staats, Jan. 26, 1949, BOB, series 39.32, file E8–21/48.1.

[6] Don K. Price, *Government and Science* (New York, 1954), p. 89.

their society and government. Now, through the Office of Naval Research, the Atomic Energy Commission, and the National Science Foundation, they were supplied with what they had been seeking for the better part of a century—a system of federal support for basic research and training insulated from political control and focused on the advancement of the best possible physics.