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SCIENCE AND TECHNOLOGY

Ronald E. Doel and Zuoyue Wang

Science did not become a major concern of U.S. foreign policy until the twentieth century. This is not to say that science was unimportant to the young republic. U.S. leaders recognized that, in the Age of Reason, the prestige of science was part of the rivalry between nations. Yet through the nineteenth century science was primarily linked to foreign policy as an adjunct of trade relations or military exploration. By contrast, mechanical ability was central to the identity of Americans, and debates about the proper role of technology in American relations to Britain and Europe raged through the late nineteenth century, as the United States gained worldwide recognition for creating the modern technological nation.

Technology—and enthusiasm for technical solutions to social problems—remained important in American foreign relations through the twentieth century. But its position relative to science changed markedly after 1900. By the start of World War II, science became a new and urgent topic for policymakers, inspiring an uneasy relationship that profoundly challenged both diplomats and scientists. As the Cold War began, the U.S. government funded new institutions and programs that linked science with diplomatic efforts and national security aims. Some were cloaked in secrecy; others were incorporated into major foreign aid efforts such as the Marshall Plan. By the late twentieth century, policymakers viewed science and technology as synergistic twins, significant yet often unpredictable agents of economic, political, and social change on both national and global scales.

THE EARLY REPUBLIC

In the earliest years of the American Republic, the ideas of natural philosophy informed the worldview of the framers of the American Constitution. The most educated of them, including Thomas Jefferson, James Madison, and Benjamin Franklin, were familiar with the ordered clockwork universe that the greatest of Enlightenment scientists, Isaac Newton, had created, and metaphors and analogies drawn from the sciences permeated their political discourse. But the pursuit and practice of science was seen as part of a transnational "Republic of Letters," above the petty politics of nations. When a group of Harvard scientists sought to observe an eclipse in Maine's Penobscot Bay at the height of the revolutionary war in 1780, British forces not only tolerated them but provided safe passage. Similarly, while Franklin was a singularly well-known scientist, widely revered in France as the founder of the science of electricity, he served as the new nation's emissary to Paris on account of his similarly impressive skills in diplomacy and familiarity with French centers of power. While a number of institutions responsible for scientific research emerged within several decades after the nation's founding, including the Coast and Geodetic Survey and the Naval Observatory, none dealt directly with areas of national policy. Alexis de Tocqueville overlooked significant pockets of learning when he declared in *Democracy in America* (1835) that "hardly anyone in the United States devotes himself to the essentially theoretical and abstract portion of human knowledge," but he was astute in observing that the "purely practical part of science"—applied technology—was what stirred the American imagination.

Still, adroit statesmen recognized that the apolitical "republic of science" could be a helpful tool in aiding foreign policy ambitions, a value connected with scientific research that would grow dramatically in later years. Exploration and geographic knowledge were important elements in contests for empire, and the nascent United States did support several successful exploring expeditions prior to the mid-nineteenth century. When President Thomas Jefferson sought to send

Meriwether Lewis and William Clark on an expedition to the Pacific northwest, but lacked funds to provide military escort, he asked whether the Spanish minister would object to travelers exploring the Missouri River with "no other view than the advancement of geography." But in his secret message to Congress in January 1803, Jefferson emphasized the value the Lewis and Clark expedition would have in aiding United States control over this vast territory. By insisting that Lewis and Clark make careful astronomical and meteorological observations, study natural history, and record Indian contacts, Jefferson underscored an important relationship between science and imperialism. A similar set of concerns motivated the U.S. Exploring Expedition (Wilkes Expedition), which between 1838 and 1842 visited Brazil, Tierra del Fuego, Chile, Australia, and the East Indies and skirted 1,500 miles of the Antarctic ice pack (providing the first sighting of the Antarctic continent). Pressure to fund the expedition had come from concerned commercial and military groups, including whalers, who saw the Pacific as important for American interests. They did not sail empty waters, for this U.S. expedition overlapped with the voyages of the *Beagle,* the Antarctic expedition of Sir James Clark Ross of England, and the southern survey by Dumont d'Urville of France, and thus owed to nationalistic as well as scientific rivalries. Yet government-sponsored expeditions in this era remained infrequent.

By contrast, technological concerns were very much on the minds of American leaders. The industrial revolution was well underway in Britain at the time of the American Revolution. Stimulated by the depletion of forests by the early eighteenth century as wood was consumed for fuel, Britain had developed coal as an alternative energy source, accelerating technological development through the steam engine (the crucial invention of the first industrial revolution) and the construction of water- and steam-powered mills. By the time of the American Revolution, British industries were supplying the American colonies with manufactured goods, spun cloth, textiles, and iron implements employed in farming. The former colonists' victory created a dilemma for the newly independent states, as Britain sought to forbid the export of machines or even descriptions of them to maintain its trading advantage. While the war in fact only temporarily cut off the United States from the output of the burgeoning industrial mills in Birmingham, Manchester, and London, and resumed migration after the war allowed mechanics to transfer technical knowledge across the Atlantic, government leaders still faced the question of what kind of material society the United States would attempt to create.

Americans at the turn of the nineteenth century agreed on one matter: they did not wish the United States to acquire the "dark satanic mills" that had made Manchester and Birmingham grimy, filthy cities, with overflowing sewers, wretched working conditions, widespread disease, and choking smoke. But American leaders also realized that a rejection of mill technology raised fundamental questions about what standards of material comfort the United States would aspire to reach, and the means, domestic and foreign, it would need to adopt to achieve those ends. Since sources of power were needed to increase living standards, how and what ways the former colonies would develop means of production or acquire finished products would help to shape the future economic, political, and social structure of the nation.

The question of whether to import the factory system to America or to encourage the growth of the United States as an agrarian nation emerged as the initial critical struggle over the role of technology in American foreign policy. It fanned intense political passions in the nascent nation, and helped shape its first political parties. Thomas Jefferson favored limiting the import of technological systems and manufactured goods. Jefferson wanted a republic primarily composed of small farmers, who as independent landowners would enhance "genuine and substantial virtue." The growth of large cities, he feared, would lead to a privileged, capitalistic aristocracy and a deprived proletariat. Jefferson's vision of an agrarian republic represented an ideal in early American political thought, popularized by such works as Hector St. John de Crevecouer's *Letters from an American Farmer* in 1782. While Jefferson was not adverse to all forms of manufacturing and would later soften his opposition to it even more, he initially envisioned a republic in which American families produced needed textiles at home and traded America's natural resources and agricultural output to secure plows and other essential artifacts. His foreign policy thus sought autonomy at the cost of more limited energy production and a lower standard of living.

Opposition to Jefferson's vision came from Alexander Hamilton, the New York lawyer and protégé of President George Washington who served as the young nation's first secretary of the treasury. Hamilton favored a diversified capitalistic economy, backed by a strong central government and import tariffs designed to nurture fledgling American industries. In his influential *Report on Manufactures* in 1791, Hamilton argued that "The Employment of Machinery forms an item of great importance in the general mass of national industry." Fearing a lack of social order from overreliance on an agricultural economy, Hamilton declared that the development of industry would encourage immigration, make better use of the diverse talents of individuals, promote more entrepreneurial activity, and create more robust markets for agricultural products. Hamilton's prescription for nationalism and his support for technology gained favor from Franklin, Washington, and John Adams, although fears of Jeffersonian Republicans that virtue followed the plow still held sway among many Americans.

By the 1830s and 1840s, Hamilton's ideas had gained the upper hand, and the federal government became a firm supporter of technological development as a promising means to promote national prosperity. Jefferson's embargo of 1807 and the War of 1812, which illuminated the vulnerability of relying on Britain for manufactured goods, helped spur this development, but another critical factor was American success in developing technologies that increased agricultural output, including the invention of the cotton gin and the mechanical harvester. The abundance of powerful rivers in New England allowed manufacturers to develop textile mills that relied on water power, initially allowing new manufacturing centers like Lowell, Massachusetts, to avoid the industrial grime of Manchester. No less important, the rapid advance of canals, river boat transportation, and especially railroads provided a model for the integration of hinter regions and seat of the nation, a means for insuring economic development and the sale of manufactured goods and products to foreign markets. For many, like the influential legislator William Seward, technology was the key to securing American domination over the continent and advancing trade. After Seward helped reinterpret patent law to insure that U.S. inventors would profit from their creations, patent numbers swelled. Patents granted rose from an average of 646 per year in the 1840s to 2,525 in the 1850s. Dreams of a global commercial empire were similarly behind American efforts to open Japan to U.S. trading after 1852, as Japan possessed the coal needed by steamships bound to ports in China. These arguments became an enduring component of American perceptions about its global role, finding expression in Alfred T. Mahan's influential late nineteenth-century work on the influence of sea power on history.

Events in the middle decades of the nineteenth century reinforced American acceptance of technology as central to national progress. U.S. manufacturing advantages became even more evident after the invention of the sewing machine and Charles Goodyear's patenting of a process to vulcanize rubber in 1844. The invention of the telegraph encouraged additional trade and opened new markets, and citizens heralded the completion of the first transcontinental telegraph cables in 1861 as a new chapter in establishing an American identity. Already ten years earlier, Americans had delighted at the positive reception British and European observers gave to U.S.-built technological artifacts exhibited at the Crystal Palace exhibition in London. The Civil War forcefully focused national attention on the production of guns and steel, but even before the war American citizens had become convinced of the value of embracing new technological systems. National desires to develop a transcontinental railroad were sufficient to overcome nativist American attitudes toward foreign labor and open the doors to the over 12,000 Chinese laborers who completed laying Central Pacific track to create the first transcontinental railroad. By the time the Centennial International Exhibit opened in Philadelphia in 1876, visitors flocking to Machinery Hall were already convinced, as Seward had argued in 1844, that technology aided nationalism, centralization, and dreams of imperialistic expansion.

THE SECOND INDUSTRIAL REVOLUTION AND THE PROGRESSIVE ERA

Three closely related factors—industrialism, nationalism, and imperialism—soon combined to reinforce American enthusiasm for technology as a key element of national policy. By the end of the nineteenth century, the first industrial revolution (begun in England and concerned with adding steam power to manufacturing) yielded to a larger, globally oriented second industrial revolution, linked to broader systems of technological production and to imperialistic practice. In contrast to the first industrial revolution, which was regional and primarily affected manufacturers and urban dwellers, the second industrial revolution

ON THE NEED TO SUSTAIN INTERNATIONAL SCIENCE AND TECHNOLOGY

"In the world of science America has come of age in the decade immediately preceding the second world war. Before this time, basic science was largely a European monopoly and Americans trained either in this country or abroad had large stores of accumulated ideas and facts on which to draw when building new industries or promoting new processes. The automobile, for example, was engineered from basic ideas many of which went back to Newton and the radio industry has developed from the late nineteenth century theories and experiments of Maxwell and Hertz. Unfortunately the technological advancements of the last war, extended as they were by every means possible, appear to have largely exhausted developments latent in the present store of basic knowledge. This means that, unless steps are taken, the technological development of really new industries will gradually become more difficult and that in time a general leveling off in progress will take place. The implication of this for America and particularly for American foreign policy could be quite serious for, if such a plateau is reached, other countries, such as Russia, could presumably catch up with or even surpass us in production and hence in military potential. The consequences of such an altered balance are not difficult to foresee. Competent American scientists have recognized this dilemma for some time and have consequently come to believe that efforts must be made to stimulate basic science throughout the world in order that subsequent development either in America or elsewhere will have something on which to feed."

— *R. Gordon Arneson,*
U.S. Department of State,
Secret Memorandum, 2 February 1950
(declassified 22 July 1998) —

introduced mass-produced goods into an increasingly technologically dependent and international market. The rise of mass-produced sewing machines, automobiles, electrical lighting systems, and communications marked a profound transformation of methods of production and economics, becoming a major contributor to national economies in America and its European competitors. Manufacturing in the United States steadily climbed while the percentage of Americans working in agriculture declined from 84 percent in 1800 to less than 40 percent in 1900.

The second industrial revolution caused three important changes in the way Americans thought about the world and the best ways they could achieve national goals. First, the process of rapid industrialism brought about a heightened standard of living for many Americans, creating for the first time a distinct middle class. By the turn of the twentieth century, the architects of the interlocked technological systems that had made the United States an economic powerhouse—from the steel magnate Andrew Carnegie to the oil baron John D. Rockefeller and the inventor and electrical systems creator Thomas Alva Edison—were increasingly represented in Washington, and their concerns helped shape foreign policy discussions. Second, and closely related, industrialization heightened an emerging sense of national identity and professionalization among citizens in the leading industrialized nations. The rise of nationalism was fueled not only by the technologies that these system builders created, but by other technologies and systems that rose with them, including low-cost mass-circulation newspapers, recordings of popular songs and national anthems, and public schools designed to instill in pupils the work ethic and social structure of the modern factory. The late nineteenth century was also the time that national and international scientific societies were created. American science was growing through the increasing numbers of young scientists who flocked to European universities to earn their Ph.D.s, carrying home a wealth of international contacts and commitments to higher standards. It was no coincidence that the rise of professional scientific communities paralleled the expanding middle class, as both groups found common support in the expansion of land-grant and private universities and in the industrial opportunities that awaited graduates of those universities. These new networks crystallized swiftly: they included the American Chemical Society (1876), the International Congress of Physiological Sciences (1889), the American Astronomical Society (1899), and the International Association of Academies (1899). The American Physical Society (1899) was founded two years before the federal government created the National Bureau of Standards, reflecting growing concerns from industrialists about creating international standards for manufacture.

Finally, the rise of advanced capitalist economies came to split the globe into "advanced" and "backward" regions, creating a distinct group of industrial nations linked to myriad colonial dependencies. Between 1880 and 1914 most of the Earth's surface was partitioned into territories ruled by the imperial powers, an arrangement precipitated by strategic, economic, and trade needs of these modern states, including the securing of raw materials such as rubber, timber, and petroleum. By the early 1900s, Africa was split entirely between Britain, France, Germany, Belgium, Portugal, and Spain, while Britain acquired significant parts of the East Asian subcontinent, including India. The demands of modern technological systems both promoted and reinforced these changes. The British navy launched the HMS *Dreadnought* in 1906, a super-battleship with greater speed and firing range than any other vessel, to help maintain its national edge and competitive standing among its trade routes and partners, while imperialistic relations were maintained by technological disparities in small-bore weapons. One was a rapid-fire machine gun invented by Sir Hiram Maxim, adapted by British and European armies after the late 1880s. Its role in the emerging arms race of the late nineteenth century was summed in an oft-repeated line of doggerel: "Whatever happens we have got / The Maxim gun and they have not."

The American experience in imperialism was less extensive than that of the leading European industrial nations, but nonetheless marked a striking shift from its earlier foreign policy. Until the early 1890s American diplomatic policy favored keeping the nation out of entangling alliances, and the United States had no overseas possessions. But by 1894 the United States came to administer the islands of Hawaii, and after the Spanish-American War of 1898 gained possession of (and later annexed) the Philippines. The story of America's beginnings as an imperial power has often been told, but the significance of technology and technological systems as a central factor in this development is not well appreciated. It is perhaps easier to see in the U.S. acquisition of the Panama Canal Zone in 1903. President Theodore Roosevelt and other American leaders recognized how an American-controlled canal would enhance its trade and strategic standing within the Pacific; they also had little doubt that U.S. industrialists and systems builders could construct it. A widely published photograph from that time reveals Roosevelt seated behind the controls of a massive earthmover in the Canal Zone. This single technological artifact served as an apt metaphor for the far larger technological system that turn-of-the-century Americans took great pride in creating.

World War I—a global conflict sparked by the clashing nationalistic aims of leading imperialist nations—pulled scientists and engineers further into the realm of diplomacy. While scientists continued to insist on the apolitical character of science, publication of a highly nationalistic defense of the German invasion of Serbia by leading German scientists in 1914 had left that ideal in tatters. More important, perhaps, was how the war educated Americans about its emerging role as a premier technological nation, and the importance of maintaining adequate sources of petroleum. After 1918, U.S. firms gained Germany's treasured chemical patents as war reparations, expanding American domination of textiles and the petrochemical industries. Americans also found that the leaders of the Russian revolution of 1917, Vladimir Lenin and Leon Trotsky, coveted American machinery and the American system of production to build the Soviet republic. By 1929 the Ford Motor Company had signed agreements with Moscow to build thousands of Ford autos and trucks, and Soviet authorities sought to adapt the management principles of Frederick Winslow Taylor in a Russian version of Taylorism.

The widening intersection between science, technology, and foreign relations was not limited entirely to contests between the United States and other imperialist powers. In the Progressive Era, biologists began to urge diplomats to aid efforts to preserve threatened species whose migrations took them across international boundaries. While efforts to ameliorate overfishing in the boundary waters separating the United States and Canada and seal hunting in the Bering Sea in the early 1890s amounted to little, a strong campaign to aid songbird populations resulted in the Migratory Bird Act of 1918 between the United States and Great Britain (on behalf of Canada), one of the most important early instances of a bilateral science-based treaty negotiated by the federal government. The significance of this treaty was not just what it accomplished (even though it served as an exemplar for other environmental treaties between the United States and its neighbors, including the Colorado River water treaty signed with Mexico in 1944). It also underscored the growing appeal of conservation values among middle- and upper-class American citizens, who joined with scientists to create nature preserves in unspoiled wilderness areas outside the United States, particularly in Africa. In such places, "nature appreciation" emerged as a commodity for tourism, its value determined by declining opportunities to experience wilderness in the North American continent. Private investments of this kind became a potent area of U.S. influence in the world's less developed areas, and took place alongside more traditional interactions including trade relations and missionary work.

WORLD WAR II AND THE EARLY COLD WAR

Science and technology entered a new phase in American foreign relations at the end of the 1930s. Gathering war clouds in western Europe convinced scientists and military leaders that greater attention had to be paid to scientific and technological developments that might aid the United States and its allies. World War II and the ensuing Cold War marked a fundamental watershed in the role that science and scientists would play in American diplomatic efforts. By the late 1940s, new institutions for international science arose within an unprecedented variety of settings (including the Department of State and the Central Intelligence Agency). Secrecy concerns influenced the practice of science and international communications, and new career opportunities arose as science and technology became significant in U.S. foreign policy as never before.

The integration of science into U.S. foreign policy during World War II initially came from the urging of scientists. In August 1939, just months after the German chemist Otto Hahn and Austrian physicist Lise Meitner, working with others, discovered that heavy atomic nuclei could be split to release energy, three scientists including Albert Einstein urged President Franklin D. Roosevelt to fund a crash program to see if an atomic bomb could be constructed. The Manhattan Project that ultimately resulted became the largest research project in the United States to date, one that involved intense and active cooperation with scientists from Great Britain and Canada. Advanced research in the United States also benefited from the emigration of outstanding Jewish scientists from Germany and Italy after the rise of Adolf Hitler and Benito Mussolini. But the atomic bomb project was only one area of international scientific cooperation: in 1940 the eminent British scientific leader Sir Henry Tizard flew to Washington on a secret mission to persuade the U.S. government to cooperate in building a system of radar and radar countermeasures. The Tizard mission laid the groundwork for effective Allied cooperation in building a wide range of science-based technological systems, including radar, the proximity fuze, and the atomic bomb. Scientists who served within the U.S. Office of Scientific Research and Development, with access to greater manufacturing capacity than Britain, also put into production the new drug penicillin.

Concern with devising new wartime weapon systems was equaled by strenuous Allied efforts to discover what science-based weapon systems Germany and Japan had constructed. Through such bilateral efforts, World War II thus nurtured two critical developments that would shape science and technology in the postwar world: the imposition of secrecy systems to protect national security concerns, and the creation of scientific intelligence programs to discover foreign progress in science and technology (particularly but not limited to advances in weaponry). Like penicillin, scientific intelligence was largely a British invention: British scientific intelligence was more advanced than U.S. efforts at the start of the war, owing to its need to buttress its island defenses. But by 1944 U.S. leaders joined Allied efforts to send scientific intelligence teams behind the front lines of advancing Allied troops in western Europe, known as the ALSOS intelligence mission. While the most famous and best-remembered goal of the ALSOS teams was to discover whether Germany had built its own atomic bomb, this was only part of its larger mission to determine German advances in biological and chemical weapons, aeronautical and guided-missile research, and related scientific and technological systems. Broad fields of science were now for the first time relevant to foreign policy concerns.

Allied scientific intelligence missions also served another function: to catalog and inventory German and Japanese research and technological facilities as assets in determining wartime reparations and postwar science policy in these defeated nations. Both Soviet and Allied occupational armies sent back scientific instruments and research results as war booty. In Germany, where the U.S. and Soviet armies converged in April 1945, U.S. science advisers sought to locate and capture German rocket experts who had built the V-2 guided missiles, including Wernher von Braun. Von Braun's team was soon brought to the United States under Project Paperclip, an army program that processed hundreds of Axis researchers without standard immigration screening for evidence of Nazi war crimes. Operation Paperclip was the most visible symbol of a concerted campaign to secure astronomers, mathematicians, biologists, chemists, and other highly trained individuals to aid American research critical for national security. In Japan, U.S. scientists focused primarily on wartime Japanese advances in biological warfare. While members of the Japanese Scientific Intelligence Mission that accompanied General Douglas MacArthur's occupation forces were unable to stop the senseless destruction of a research reactor by U.S. soldiers, science advisers successfully insisted that applied science and technology were critical components of Japan's economic recovery.

Above all it was the use of atomic weapons against Japan in the closing days of World War II that brought science and technology into the realm of U.S. foreign policy as never before. The roughly 140,000 who died immediately at Nagasaki and Hiroshima, combined with the awesome destructive power of a device that relied on the fundamental forces of nature, made the atomic bomb the enduring symbol of the marriage of science and the state. In subsequent decades the U.S. decision to employ atomic weapons has become one of the most fiercely debated events in American foreign policy. Even before the bomb decision was made, a number of American atomic scientists protested plans to use nuclear weapons against Japan since it, unlike Nazi Germany, lacked the capacity to construct atomic weapons of its own. How the decision to use the bomb was made has split historians. Some have argued that U.S. leaders sought to end the war before the Soviet Union could officially declare war on Japan and thus participate in its postwar government, but many have concluded that other motivations were at least as important, including fears that Japanese leaders might have fought far longer without a show of overwhelming force and domestic expectations that all available weapons be used to conclude the war. Others have pointed out that U.S. policymakers had long seemed especially attracted to the use of technology in its dealings with Asian countries.

The largest conflict over nuclear weapons in the immediate postwar period involved the American monopoly over them, and how the United States could best safeguard the postwar peace. Bernard Baruch, the financier and statesman, proposed that atomic power be placed under international control through the newly established United Nations. The Soviet Union vetoed the Baruch Plan, believing that the proposal was designed to prevent it from acquiring nuclear weapons. Meanwhile, conservatives promoted a congressional bill that placed atomic energy under military control. Liberal scientists opposed the bill and advocated civilian control instead. In 1946, with the support of President Harry S. Truman, a Senate committee under Brien McMahon drafted a new bill that eventually resulted in a civilian-led (but militarily responsive) Atomic Energy Commission (AEC), one of the first postwar agencies designed to address science in foreign policy.

As the Cold War began, debate over science and technology in American foreign policy split along familiar lines. The most well-known of these involved efforts to maintain the deeply eroded traditions of scientific internationalism. Atomic scientists who supported international control of atomic energy created new national organizations, including the Federation of American Scientists. Participating scientists, including Albert Einstein, argued that physicists could aid the development of world government that would avoid the political perils of atomic warfare. In July 1957 nuclear scientists convened the first Pugwash meeting, drawing nuclear scientists from Western and communist nations to discuss approaches to nuclear disarmament. But promoters of scientific internationalism were not solely interested in atomic issues. The liberal internationalist and Harvard astronomer Harlow Shapley backed prominent British scientists Julian Huxley and Joseph Needham in their efforts to highlight science within the United Nations Educational, Scientific, and Cultural Organization (UNESCO). Leaders of the Rockefeller Foundation launched major new science initiatives in Latin America, while the National Academy of Sciences urged policymakers not to restrict American access to the world community of science. While public support for these positions remained high during the early years of the Cold War, they faded after Soviet Premier Joseph Stalin resumed a well-publicized crackdown on "bourgeois" research in genetics in favor of Trofin Lysenko's promotion of Lamarckian inheritance. This repression convinced many Americans that objective Soviet science had succumbed to state control. By the McCarthy era unrepentant internationalists were targets of a growing conservative backlash. The biochemist and Nobel Laureate Linus Pauling—who won a second Nobel Prize in 1962 for his campaign to end nuclear testing—was one of several outspoken American scientists whose passport was temporarily revoked in the 1950s.

At the same time, other scientists began working with government officials in Washington, sometimes clandestinely, to investigate ways that scientists could aid U.S. national security by addressing major issues in American foreign policy. These activities took many forms. One of the more visible steps came in 1949, when President Truman announced, as the fourth point of his inaugural speech, that the United States was willing to "embark on a bold new program for making the benefit of our scientific advances and industrial progress available for the improvement and growth of under-developed areas." After Congress approved the so-called Point Four program a year later, tens of millions of dollars supported bilateral projects in science education, public health, agriculture, and civil engineering, adding to mainstream Marshall Plan funds used to restore technological and scientific capacity in the war-ravaged nations of western Europe. At the same time, U.S. scientists and technical experts worked to thwart Soviet efforts to obtain advanced Western computers, electronic devices, and other technologies and resources critical to weapons development. These included efforts to limit export of weapons-grade uranium to the Soviet Union and to deny Soviet access to Scandinavian heavy water as well as prominent Swedish scientists in the event of a Soviet invasion.

For U.S. policymakers, a principal challenge was to secure reliable overt and covert information on the scientific and technological capacity of other nations, since such intelligence was necessary to match enemy advances in weaponry—particularly in biological, chemical, and radiological warfare. A major point of intersection between physicists and U.S. policymakers came in efforts to discern Soviet advances in atomic bomb work and in developing methods to detect and analyze Soviet atomic tests, a task that gained greater urgency after the Soviet Union exploded its first nuclear device in August 1949. Hindered by a paltry flow of overt information from communist countries, U.S. scientists sought alternative means to secure such data. In 1947 several scientists who had managed the wartime U.S. science effort, including Vannevar Bush, James Conant, and Lloyd V. Berkner, helped create a set of new institutions devoted to the role of international science in national security. The first was the Office of Scientific Intelligence within the newly formed Central Intelligence Agency. Three years later, scientists working with the Department of State created a scientific attaché program, patterned on the U.K. Science Mission. A 1950 Berkner report to Secretary of State Dean Acheson, justifying this effort, declared that the program would strengthen Western science while providing American scientists and businesses helpful information; a secret supplement optimistically spelled out ways that attachés could covertly secure needed intelligence. Yet by 1952, national security experts concluded that foreign science and technology intelligence-gathering from the CIA and the Department of State remained woefully inadequate. The United States then created the top-secret National Security Agency to foster signals intelligence, employing the clandestine code-breaking strategies that had aided Allied victory during World War II.

Scientists and policymakers both found the abrupt integration of science into U.S. foreign policy unnerving. Many American scientists recognized that post-1945 national security concerns required pragmatic compromise of the unfettered exchange of information that had long been the ideal of science. The close relations that developed between scientists and the government during World War II also helped certain scientists undertake clandestine research programs. But most American scientists resented increasingly tight security restrictions, demands for secrecy, loyalty oaths, and mandatory debriefings by federal agents following overseas professional trips. Scientists who accepted posts in the State Department felt the snubs of colleagues who regarded such service less prestigious than lab-bench research. For their part, traditional foreign relations experts, trained in economics or history, were largely unfamiliar with the concepts or practices of science, disdained the capacity of scientists in war-ravaged western Europe and the Soviet Union to produce quality science, and perceived the inherent internationalism of scientists suspicious if not unpatriotic. Such views were widespread within the national security bureaucracy. Federal Bureau of Investigation director J. Edgar Hoover, familiar with top-secret Venona intercepts of encrypted Soviet communications used to discover atomic spies in the United States, regarded the internationalism of scientists as a threat to democracy and the proper aims of U.S. foreign policy.

Despite these mutual tensions, American leaders in the 1950s nonetheless sought to use science to influence foreign policy debates. Officials used scientific intelligence to refute highly publicized (and still unresolved) Chinese claims that American forces in Korea had violated international accords by employing bacteriological weapons in the winter of 1952. Even greater use of science as an ideological weapon was made by President Dwight Eisenhower, who in a major speech to the United Nations General Assembly in December 1953 offered his "Atoms for Peace" proposal calling for the peaceful uses of atomic power. Regarded at the time as a Marshall Plan for atomic energy, Atoms for Peace promoted the development of nuclear cooperation, trade, and nonproliferation efforts in noncommunist nations; it also provided nuclear research reactors to countries in South America and Asia. Eisenhower's advisers felt certain that the Soviet Union could not match the Atoms for Peace offer, and hence would suffer a political setback as a result. They also believed it would reduce the threat of nuclear warfare, an anxiety shared by western European leaders after the United States explicitly made massive retaliation the cornerstone of its national security policy.

Historians have debated the significance and meaning of the Atoms for Peace proposal. On the one hand, some maintain that Eisenhower correctly perceived that the most effective means of halting nuclear proliferation would come from promoting and regulating nuclear power through the auspices of the United Nations, while ensuring that the European western democracies would gain direct access to what at the time seemed a safe and low-cost source of energy. The program helped the United States secure 90 percent of the reactor export market by the 1960s. On the other hand, critics charge that Atoms for Peace actually served to increase the danger of nuclear proliferation. Yet other historians regard Atoms for Peace as part of a grander strategy to mute criticism of the accelerated buildup of U.S. nuclear weapons stockpiles and their secret dispersal to locations around the world, including West Germany, Greenland, Iceland, South Korea, and Taiwan. It is also clear that Eisenhower sought to exploit the apolitical reputation of science to wage psychological warfare and to gather strategic intelligence. In the mid-1950s the Eisenhower administration approved funds for the International Geophysical Year (IGY) of 1957–1958, an enormous effort to study the terrestrial environment involving tens of thousands of scientists from sixty-seven nations (a plan conceived, among others, by science adviser Lloyd Berkner). In one sense, Eisenhower's support for the IGY was overdetermined: policymakers saw an advantage in limiting rival nations'

ON SCIENTIFIC INTELLIGENCE

"Historically, the major responsibility for intelligence in the United States, both during war and peace, has rested upon the military agencies of the government. Since World War II, intelligence has assumed a far greater peacetime role than heretofore and has had an increasing influence upon foreign policy decisions.

"In the overall utilization of intelligence in the policy making areas of the Department [of State], there appears to be too little recognition of the enormous present and future importance of scientific intelligence. In the past, military and political factors, and more recently economic considerations, have been the controlling elements in estimating the capabilities and intentions of foreign powers. Now, however, an increasingly important consideration in any such assessment is the scientific progress of the country concerned. For example, the determining factor in a decision by the U.S.S.R. either to make war or to resort to international political blackmail may well be the state of its scientific and technological development in weapons of mass destruction. It is therefore imperative that, in the Department, the scientific potential and technical achievements of the Soviet Union and their implications be integrated with the other elements of a balanced intelligence estimate for foreign policy determination."

— Lloyd Berkner, Report of the International Science Policy Survey Group (Secret), 18 April 1950 (declassified 22 July 1998) —