such facility in the world. Under the direction of William H. Park, diphtheria diagnosis and antitoxin production and distribution soon became the laboratory's principal activities, setting an example for public-health agencies around the country.

At the Massachusetts Department of Health in 1909, Theobald Smith demonstrated that a mixture of toxin and antitoxin can confer immunity to diphtheria. In 1916 Alfred Hess of New York introduced active immunization with toxin-antitoxin. Despite reservations about it—because of its potential toxicity and possible allergic reactions to the horse serum—public-health authorities encouraged vaccination with toxin-antitoxin.

In 1913 Bela Schick, then at the University of Vienna and later to move to New York, announced a simple test to determine susceptibility to diphtheria. In contrast to smallpox vaccination, which had been mandatory in many American jurisdictions for decades, the campaign for vaccination against diphtheria relied on education of the public through the mass media. An example is the extensive press coverage of the relatively small 1925 outbreak in Nome, Alaska. Headline stories around the United States described the great effort taken to get antitoxin to Nome in a 5-day, 674-mile sled relay involving no fewer than 24 mushers and 150 dogs.

Although contemporaries had reason to question the efficacy of antitoxin in its early years, product standardization and further scientific developments were probably responsible for dramatic declines, first in case mortality and later in incidence. During the 1920s, the French veterinarian Gaston Ramon showed that diphtheria toxin could be rendered harmless although still able to stimulate the body's production of antitoxin. Called toxoid or anatoxine, it was soon was adopted as an immunizing agent.

During the 1920s, the United States annually experienced about 150,000 diphtheria cases and 13,000 deaths. By 1945, the number of cases had dropped to fewer than 20,000. In the postwar period, immunization has led to the virtual eradication of diphtheria in the United States. Fifty-two cases were reported between 1980 and 2004 and a total of only 5 since the year 2000.

[*See also* **Disease; Germ Theory of Disease; Medicine;** *and* **Public Health.**]

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Edward T. Morman

DIPLOMACY (POST-1945), SCIENCE AND TECHNOLOGY AND

The role of science and technology as instruments of American foreign policy is often overlooked, in part because it calls for integrating insights from academic disciplines that barely, if ever, intersect. The field of diplomatic history and American foreign policy has long since moved beyond the narrow study of the relations between high-level state officials to incorporate the place of culture, ideology, and gender into its analyses of interstate relationships—but it usually stops short of science and technology. Of course there is an extensive literature on the role of the atomic and hydrogen bombs in diplomacy beginning in 1945, but even here the weapons are taken as an already available negotiating tool and reduced to their performance characteristics. The dynamics of the vast research and development complex that produced them is not considered, although it was a constitutive component of American power in the postwar period and shaped the strategic options that were available to negotiators in interstate relations. Historians of American science and technology, for their part, have enriched our understanding of the many ways in which research and development in academia, in think tanks, in industry, and in government laboratories were harnessed to the chariot of the national security state that emerged after 1945. They have shed light on the functioning of the national innovation system but, although they recognize that the system provides invaluable resources for the expression of American power, they usually do not study how those resources were mobilized as instruments of statecraft. Put rather crudely, if diplomatic historians have tended to focus on use and to ignore the innovation that lies behind it, historians of science and technology have tended to focus on innovation, pushing use to the background. The former black-box the knowledge (in all its forms) that bubbles up from the national research system and that is constitutive of American power. The latter probe into the black box and describe the intricacies of the processes therein that produce knowledge, but they rarely follow science and technology beyond the laboratory and the national frame as it circulates into the wider world.

In recent years there has been a welcome move by scholars on both sides of the divide to dissolve the disciplinary boundaries between the histories of science and technology and that of American diplomacy and foreign policy (Adas, 2006; Engerman, 2007; Hecht, 2012; Krige, 2006; Krige and Barth, 2006; LaFeber, 2000; Westad, 2000). A narrow conception of the Cold War as a bipolar confrontation between the superpowers has yielded to a far more nuanced understanding of the postwar period. Collaboration and cooption coexisted with competition, nation building with war mongering, spectacular demonstrations of scientific and technological prowess with wide-ranging restrictions on the flow of knowledge (Connelly, 2008; Cullather, 2010; Krige, 2008; Manela, 2010; Van Vleck, 2009; Wang, 2010). This essay is situated within this emerging framework. It takes a thematic and conceptual approach, rather than a predominantly chronological one, highlighting the many different ways in which the natural and social sciences and technologies were mobilized as instruments of foreign policy after World War II.

Leadership is the capacity to move proactively, and ahead of others, into uncertain territory, taking bold initiatives and investing resources to meet a difficult challenge, inspiring other stakeholders, and even demanding that they 'follow' for fear of being marginalized. Here the ideology of leadership serves as a focal point that gives meaning *both* to the U.S. government's sense of its role in the world *and* to the federal government's massive investment in research and development after 1945. It was as leader of the "free world" that successive American administrations devoted vast resources to science and technology to confront and fight their enemies, to collaborate with friend and foe alike, to modernize the third world, to "Americanize" the globe, and to symbolically express national power and prestige. Disaggregating the relationship among science, technology, and foreign policy along these axes has its limitations—some topics are handled more than once under different themes, there is a greater emphasis on the first two or three decades of the Cold War than on the later period (as is to be expected with archival-based scholarship), and transitions are sometimes abrupt. At the same time, by their very sweep, these fragments collectively hint at the immense richness of a field of research that is still fluid and in formation.

Periodization. The geopolitical situation was not static during the Cold War. Containment and confrontation gave way to "peaceful coexistence" and détente, followed by another period of intense confrontation in the 1980s that ended with the implosion of the Soviet Union. Nor was the course of history in the 1950s and 1960s simply defined by relationships between

Washington and Moscow (and their allies). Its physiognomy was also shaped by the emergence of new and influential actors on the global stage: the United Nations and its agencies and the tens of decolonized states in Africa and Asia whose historical trajectories moved at a different rhythm, intersecting with those of the dominant powers in complex ways. In addition, the world order began to be reshaped in the 1970s by technologically supported global interconnections that spawned interdependence, diluted state sovereignty, and enabled a power shift in favor of nonstate actors (multinational corporations, giant foundations, and well-organized issue-driven pressure groups, for example). This essay cannot hope to do justice to this rich tapestry; it seeks only not to lose sight of it.

Leading. The United States emerged from World War II as the major economic, industrial, and military power on the globe with broad international support for its democratic ideals. We should not forget, however, that there was also a major asymmetry in scientific and technological capability between America and its allies and enemies. The debate on how best to maintain that preeminence got under way before the war was over. It was focused by the consolidation of Communist regimes in Eastern Europe and in China in the late 1940s, followed by the outbreak of the war in Korea in June 1950, and it was given urgency by the first Soviet atomic test in August 1949. National Security Council Document 68 (NSC68), an official doctrine approved in April 1950, described the United States as being faced with an existential threat from an implacable enemy that espoused values that were completely irreconcilable with those that the country held dear. The United States could not meet "hordes with hordes," however. For President Eisenhower, the security of the West, a budget that balanced military and civilian needs, and the protection of domestic liberties and pluralistic institutions could only be achieved by substituting firepower for manpower, quality for quantity. The permanent military preparedness needed to meet the Communist threat called for ceaseless innovation to maintain a comparative technological advantage over friend and foe alike. This quest for scientific and technological preeminence, or "leadership," was called for by Vannevar Bush in 1945, was enthusiastically embraced by the scientific elite, and was fueled by Soviet achievements in the 1950s. It provided—and still provides—the dominant rationale for the sponsorship of research and development (R&D) both for and beyond the needs of the national security state. The federal government's R&D budget, initially modest, increased dramatically after the Korean War broke out and was given another enormous boost by the launch of *Sputnik* in 1957. By 1967, at the height of the Apollo lunar program, federal spending on defense and nondefense R&D had reached a staggering $82 billion (in constant FY2008 dollars), more than quadrupling in a decade. Private industry added half as much again (American Association for the Advancement of Science [AAAS], 2008, 1953).

The pursuit of scientific and technological "leadership" resonated with, and gave substance to, a national security ideology premised on the assumption that peace and freedom were indivisible and that a threat to democracy anywhere was a threat to democracy everywhere, so also to the United States. The "internationalists" in Congress who promoted this view gradually asserted their authority over "isolationists" who balked at foreign entanglements. As Michael Hogan puts it, it became widely accepted by 1950 that the "leadership of the free world was a sacred mission thrust upon the American people by divine Providence and the laws of both nature and history" (Hogan, 1998, p. 15). Assuming the mantle of global leadership—some would say dominance—and proclaiming its rejection of imperial modes of governance, the United States sought to make the world safe for democracy.

The quest for leadership is the node that fuses the pursuit of scientific and technological superiority with a foreign policy that aspires to political, economic, ideological, and military dominance. It binds the innovation system to America's global ambitions, embedding the national in the international. Securing scientific and technological "leadership" became the single most important argument for the ongoing support for R&D by government and industry alike, a spontaneous ideology that was so widespread as to be invisible. Similarly, falling behind in any significant domain of science and technology ignited declinist fears and encouraged the view that its competitors were overtaking the United States. After 1945, constant innovation and the rapid transformation of new knowledge into useful devices were widely understood to be necessary for maintaining national vitality and for the successful projection of American power abroad.

Confronting. From the dawn of the atomic age, nuclear weapons and their delivery systems were at the heart of international diplomacy. Their capacity to change the dynamics of foreign policy was evident immediately after the Trinity test in July 1945 that confirmed the functioning of the implosion device on the plutonium bomb. President Truman's former enthusiasm to have Stalin enter the war against Japan turned to chagrin: here was another way to end the war quickly without offering the Soviets a foothold in the Pacific theater. The atomic bomb was the winning weapon, and the United States did all that it could to retain its monopoly after 1945. The first successful Soviet test in 1949 created a window of opportunity for the development of the hydrogen bomb, opposed strongly by some physicists as genocidal, but supported equally volubly by others as essential to security and to stop the United States from becoming a second-class world power. The arms race was under way, carried on a wave of scientific and technological enthusiasm that transformed the practice of the sciences and the training of physicists, in particular, and that satisfied the open-ended requests of all the armed services for the most up-to-date delivery systems. In parallel, first Britain (1952), then France (1960), and then China (1964) successfully tested atomic weapons as much to enhance security as to affirm their status as great powers: one was nuclear or one was negligible, as a French minister of defense put it in 1963.

By 1955 the four powers (Britain, France, the United States, and the USSR), meeting in Geneva, recognized that nuclear war with the weapons already available would be suicidal for the combatants. Nuclear stockpiles continued to grow nevertheless, driven by mutual suspicion and distrust. By 1960 the U.S. nuclear weapons stockpile counted almost 20,500 warheads; the Soviet Union's numbered some 1,600 (National Resources Defense Council [NRDC], 2002). During the 1960s the United States deployed over a thousand intercontinental ballistic missiles (ICBM) and hundreds of submarine-launched missiles in the Polaris (and later Poseidon) systems and developed accurately guided, multiple independently targetable reentry vehicles (MIRVs) for both. The Soviet ICBM arsenal matched this in size by the end of the decade. During the 1970s the United States' advantage was gradually offset by the formidable SS-17s and SS-18s and then the SS-20s that were protected in hardened silos, were highly accurate, could carry up to as many as 10 MIRVed warheads, and benefited from improved command and control systems.

Each incremental increase in capability rendered the use of nuclear weapons less likely. The Cuban missile crisis in 1962, which brought the world to the brink of nuclear war, persuaded President Kennedy and President Johnson after him that nuclear weapons were effective in deterrence but unusable in offense. Nuclear strategy was devised not to win wars but to avert them, as one theorist put it. Although thousands of warheads were stationed in the European theater, new policies like "flexible response" were devised to fight wars using conventional means behind the nuclear shield.

Several international efforts were made to contain the threat of nuclear war and to limit the escalation of nuclear capabilities. In 1963 the superpowers signed a partial-test-ban treaty that forbade all nuclear tests except those conducted underground. A treaty on the nonproliferation of nuclear weapons (the NPT) was signed in London, Moscow, and Washington in 1968. Agreement between its proponents was only possible because it did not require any of the existing nuclear powers to renounce their weapons, while denying them to any signatory that did not already have them, most notably Germany. The NPT was followed in 1972 by a treaty limiting the use of anti–ballistic missile systems to defend countries from an attack by nuclear-tipped strategic missiles (the ABM treaty).

These treaties were the high-water mark of nuclear diplomacy between the superpowers. The United States unilaterally withdrew from the ABM treaty in 2002. A comprehensive test-ban treaty was adopted in 1996 but in 2012 still waited on signature and/or ratification by numerous nuclear weapons states, including China, India, North Korea, Pakistan, and the United States.

The massive quantitative increase in the nuclear arsenals of both superpowers in the 1960s and 1970s was followed by a qualitative change in the destructive power of America's arsenal in the 1980s. Weapons designers at Livermore and Los Alamos, the two major national laboratories, worked on so-called third-generation nuclear weapons (succeeding the atomic and hydrogen bombs). These devices focused the explosive power of a bomb, increasing the energy it delivered on a target a thousandfold. They could also be used to produce intense beams of directed energy, as in an X-ray laser "pumped" by a concentrated nuclear explosion. Complementing these innovations, President Ronald Reagan's Strategic Defense Initiative (SDI) planned for the deployment of a variety of high-power directed beam weapons to destroy incoming enemy ballistic missiles. Although SDI was presented as purely defensive, it also offered offensive possibilities. Placed in outer space, a variety of powerful beams could do considerable damage in nanoseconds to installations on Earth. American policy makers insisted that this option was of no strategic interest, even if it was technically possible. The Soviets were not convinced and refused to accept on trust that a space-based offensive capability would not be used against them simply because the United States' existing ballistic missile system rendered it strategically redundant.

The deployment of dual-use technologies in space increased after the Reagan years, stretching to the limit the constraints imposed by the treaty on the "peaceful uses" of outer space negotiated in the early 1960s. In 2012, space-based communications systems were strategically important as force multipliers in war. They also served as information highways that were central to the functioning of the global economy. The development of antisatellite weapons by several countries, including China, posed a grave threat to these assets.

The credibility of a strategic posture based on ballistic missiles topped with nuclear weapons depended on intelligence of many kinds that was derived from many different sources. The Corona series of spy satellites provided invaluable images of Soviet missile complexes, identified ABM sites and defensive missile batteries, and provided inventories of Soviet bombers and fighters and data on surface and submarine ocean fleets, in addition to verifying arms control agreements. Other modes of information gathering relied directly on human insight and learning. The Central Intelligence Agency (CIA) and other government agencies mobilized countless scientists and engineers as informal intelligence gatherers to gain access to security-related information, much of which was readily available in an open society. The agencies used these intelligence gatherers to glean what knowledge they could of the state of military programs abroad by chatting with colleagues from the Soviet Union and other sensitive countries at international conferences and workshops, debriefing them when they returned home.

The humanities and social sciences played their part too. The Department of State placed great store in training diplomats in foreign languages for new international responsibilities. The military needed people who were competent in foreign languages for intelligence purposes. They also invested over $20 million in machine translation between 1945 and the mid-1960s, one of the first uses of computers for nonnumerical tasks. Organizations like the American Institute of Physics supported the translation of leading Soviet science periodicals into English. The Eisenhower administration was so convinced of the strategic importance of learning foreign languages that it was identified as second only to improved training in mathematics and science in the National Defense Education Act passed in 1958, in the wake of the *Sputnik* shock. Area studies also blossomed with support from both the federal government and foundations. Columbia University's Russian Institute and Harvard's Russian Research Center led the way in the late 1940s; by the mid-1960s Russian studies were offered in many major universities across the nation. "Sovietology" sought to combine academic excellence with political pluralism to produce useful knowledge for those who made American foreign policy. The Cold War channeled billions of dollars into R&D that satisfied the exigencies of the national security state, but it also provided unprecedented resources that secured America's preeminence at the cutting edge of knowledge production in many domains of natural and social science and engineering.

Fighting. A long peace reigned over much of the industrialized north since 1945 despite—or thanks to—the massive concentration of lethal weaponry in the hemisphere. The suicidal consequences of unleashing their arsenals on each other, which kept their confrontation "cold," did not stop the United States and the Soviet Union (and not only them) from becoming entangled in "hot" wars, sometimes far beyond their shores in Asia, Latin America, and Africa. In 1992 Francis Fukuyama saw the collapse of the Soviet Union as signaling the "end of history"; his celebration of the triumph of liberal democracy was short-lived. The People's Republic of China emerged as a major global player, the number of nuclear powers proliferated, and radical Muslim fundamentalism gained in strength. During the late twentieth and early twenty-first centuries, the expansionist ambitions of both Iraq and Iran, an ongoing crisis of governance in Afghanistan, and the terrorist attacks of 11 September 2001 dragged the United States into a series of wars in the Middle East whose costs were enormous and whose end was difficult to define and to discern. To meet these new and different threats, the federal defense budget increased dramatically (in 2012 dollars) from just under $300 billion in 2000 to almost $700 billion in 2010 (Office of Management and Budget [OMB], 2012). In 2012, federal spending on defense and nondefense R&D (in constant 2008 dollars) was around $140 billion, an all-time high, and considerably above the peak it reached in the mid-1980s, about $95 billion (AAAS, 2008).

These dollars translate into the development and deployment of increasingly sophisticated weapons systems that hold the promise of achieving victory at terrible cost to the enemy with limited loss of American life. In the Vietnam War the then-new technology of the armed helicopter, widely known as the Huey, significantly enhanced battlefield mobility. Nearly 20 million gallons of Agent Orange and other novel herbicides and defoliants denied cover and food to enemy forces and permitted the more efficient use of aerial power, destroying 25 million acres of agricultural land in central and southern Vietnam. A group of brilliant physicists and chemists gathered together in the Jason group devised an innovative "electronic battlefield" in which hidden sensors detected the movements of trucks and guerillas through dense vegetation. The output from the sensor network was distinguished from false alarms using two IBM 360 computers, displayed on a large screen, and transmitted to dedicated attack aircraft, ideally on call at all times. Although the actual value of the system is contested, it did form the basis for what is today called Network-Centric Warfare, or a "sensor-to-shooter" link in military parlance. So, too, the origins of precision-guided air-to-ground weaponry as well as the now ubiquitous infrared search and weapon-aiming equipment can be traced back to the Vietnam War. Each conflict served as a laboratory and a proving ground for the next.

Eisenhower's ambition to replace personnel by capital-intensive nuclear weapons, to overwhelm quantitative enemy superiority with qualitative technological advantage, has become the general leitmotif of U.S. military thinking. In 2012 all three branches of the armed services had weapons that were unmatched by those of any other country. The U.S. Air Force, for example, was in the position of acquiring five different types of stealth aircraft; no other nation had any. Global positioning system (GPS) satellites combined with joint surveillance and target radars guide "drones" (unmanned aerial vehicles) that strike with ruthless precision; no one else could do this on the same scale. Military supremacy derived from scientific and technological preeminence, spectacular displays of technical prowess, embedded journalists who send optimistic reports back to the home front, and relatively few U.S. casualties (about 4,500 in nine years of Operation Iraqi Freedom) make high-tech war an attractive instrument of diplomacy for American presidents, politicians, and the public alike.

Collaborating. Collaboration is usefully distinguished from cooperation. Cooperation typically involves the circulation of knowledge through conferences, workshops, and informal face-to-face encounters, and it is usually limited to data sharing. Collaboration requires a greater investment than cooperation. In collaboration data are not simply pooled; knowledge is coproduced. This knowledge is a key resource for the stakeholders involved, whose capacity to exploit collaboration to their advantage is determined by what they bring to the table and what others want from them. No partner gives away a competitive edge in a collaborative engagement unless there is something to gain from it. Collaboration requires reciprocity for it to succeed; cooperation is less demanding.

The confrontational rhetoric of the early Cold War can easily blind one to the parallel cooperative and collaborative efforts undertaken by multiple actors in the United States to defuse tension and to build alliances. In his Annual State of the Union address in 1958, in the wake of the Soviet launch of *Sputnik*, President Dwight D. Eisenhower warned that Moscow was waging "total Cold War" in which "trade, economic development, military power, arts, science, education, the whole world of ideas—all are harnessed to the same chariot of expansion." The International Geophysical Year (IGY) was in full swing even as he spoke. The IGY ran from July 1957 to December 1958. It is usually remembered as inaugurating the space race, which animated Eisenhower's address. But it was also one of the first major cooperative events between scientists and their national societies in the United States and the Soviet Union. It engaged tens of thousands of practitioners from more than three score countries. And it provided a vast amount of data on the properties of the earth, the oceans, and the upper atmosphere. The IGY not only paved the way for closer American–Soviet cooperation in fields like meteorology and oceanography that called for global data collection, but also stimulated the creation of international scientific networks that transcended national boundaries and provided an opportunity for elites to maintain lines of communication and of solidarity, even when tensions persisted between their governments. The physicist-led Pugwash conferences that have brought together influential scientists, policy makers, and state officials since 1955 to reduce the threat of nuclear war represent just one of the most visible transnational networks that have sought to dissolve national borders and to promote peace as a dominant foreign-policy objective in a divided world.

Collaboration burrows to the core of national scientific and technological assets and can forge close international alliances on the basis of reciprocity in knowledge flows. In 1958 the United States formally suspended the draconian restrictions on nuclear sharing demanded by the 1946 McMahon Act. It now allowed for military cooperation with countries that had made "substantial progress" in the nuclear field—a form of words intended to single out the United Kingdom and to exclude France. The move was made only after weapons scientists had assured the U.S. Congressional Joint Committee on Atomic Energy that the British were well advanced with their hydrogen bomb and the United States had something to learn from them. Thereafter, there was a continuous exchange of sensitive knowledge across the Atlantic that consolidated the Anglo-American "special relationship." Britain remained a junior partner all the same. The country had to tie itself to American priorities in research to benefit from what the United States had to offer. It was obliged to sacrifice a degree of control over its "independent" nuclear deterrent. And it was also led to believe that its privileged nuclear links could be jeopardized if it did not support American foreign-policy objectives in the United Nations, Europe, and the Middle East.

The U.S. State Department and the Atomic Energy Commission also tried to exploit American scientific and technological leadership to promote the construction of a "United States of Europe" around a variety of technological platforms. In the late 1950s, with the active support of President Eisenhower, it enthusiastically supported the formation of the European Atomic Energy Community, Euratom. Euratom was formally established, along with the European Economic Community, by the Treaties of Rome signed in March 1957. In supporting a joint research effort under its auspices, Washington hoped to lever the United States' putative lead in nuclear power research, development, and production to consolidate a united Europe, to create markets for American reactor firms, and to force European governments (particularly France) to funnel limited amounts of money, brainpower, and industrial capacity into a collaborative civilian nuclear effort at the expense of national and military weapons programs.

France was again the target of American concern in the mid-1960s when it complemented its nuclear arsenal with the successful launch of its own satellite using an adapted ballistic missile developed domestically. Now it was the National Aeronautics and Space Administration (NASA) that sought to lever America's lead in the space sector by offering to share advanced rocket technology with a floundering civil, European-wide, launcher development program. Again, the hope was that the development of a robust, supranational civil satellite launcher would divert scarce resources away from national missile programs. Europe's relative penury, and its dependence on American science and technology to modernize efficiently, provided Washington with an opportunity to lever its leadership in strategic sectors like the nuclear and space programs to build a united Europe and to contain "runaway modernity" on the continent.

The promise of broad technological collaboration in civil nuclear energy was also the incentive offered to non–nuclear weapons states if they agreed to renounce acquiring weapons of mass destruction. This was the grand bargain struck in the treaty on the nonproliferation of nuclear weapons in 1968. It offered the "fullest possible exchange" of equipment, materials, and scientific and technological information pertinent to the peaceful use of nuclear energy if the then-non-weapons states formally accepted their existing status. Brokered after long and difficult negotiations between the United States and the Soviet Union, the nonproliferation treaty established an international regime that is variously described as entrenching "nuclear apartheid," as impotent in the face of the determination of countries like Israel, India, and Pakistan to develop nuclear weapons, as unable to reign in the actions of particularly dangerous proliferators like Iran and North Korea, and as having played a major role in stabilizing world order for 40 years and beyond Cold War rivalries.

Technological denial has the inverse effect to technological collaboration. In the late 1960s NASA strongly encouraged extensive European technological participation in the development of the space shuttle, only to back off under pressure from White House staffers in the new Nixon administration. They were hostile to sharing advanced American aerospace technology when, in their view, the United States got so little in return. The results were predictable: Gaullist forces in France, determined to secure the political and commercial benefits of an autonomous access to space, successfully championed the development of a European heavy launcher, Ariane. Technological collaboration locks allies into one's orbit; technological denial reinforces aspirations to national autonomy, strains alliances, and breeds resentment.

The close relationship among science, technology, and national security after 1945 imposed tight restrictions on the free circulation of sensitive knowledge. The Atomic Energy Act of 1946 broke all precedent by declaring that all knowledge that was pertinent to nuclear weapons, including the production of nuclear material and its use for the production of energy, was restricted data and so was exempt from the sacred principles enshrined in the Freedom of Information Act. No government action was needed to classify it: it was "born secret." These tight controls were somewhat relaxed in 1954 under pressure from American industries that wanted to sell nuclear reactors as part of the Atoms for Peace program. Special arrangements were also made with some European allies, led by Britain, to collaborate on weapons development and uranium enrichment behind security walls. The cumulative effect of the born-secret policy was daunting. In 1995 the Department of Energy estimated that it held at least 280 million classified pages of material that would take nine thousand person-years of effort to review, an impossible task. This mass exploded after new restrictions on the free circulation of information were imposed after the terrorist attacks of 2001 and the fear that biological weapons might be used against the United States. In the early twenty-first century, international scientific and technological collaboration was increasingly regulated by a range of restrictions that penetrated into the laboratory, even when unclassified work was being done, frustrating American scientists and corporations and alienating traditional allies.

Modernization. In 1945 there were 51 sovereign states in the world; 20 years later, in 1965, the number had more than doubled to 117. The Third World emerged with its own identity—desperately poor, increasingly overcrowded, and trapped in a cycle of misery. No new nation engaged in the postcolonial process of state formation could remain indifferent to the competing models of society that were being promoted by Washington and Moscow to propel them into modernity. For the United States, the teeming masses posed a threat to world order, a breeding ground for Communism that had to be eradicated by transforming traditional habits and social structures.

In January 1949 President Harry Truman committed the United States to intervene on behalf of the wretched of the earth. In "Point IV" of his inaugural address he pledged to use America's preeminence in science, technology, and industry to help people in "underdeveloped areas" learn to help themselves. In one stroke he defined the Third World in terms of a lack, he undertook to help steer it on the path to development and modernization, and he singled out "our imponderable resources in technological knowledge" as the single most important instrument that would be brought to bear "to help them realize their aspirations for a better life."

The language of "development" provided a policy goal that all could share. It fused the local aspirations of national elites with the global ambitions of the industrialized powers. It was not tarnished by the presumption of superiority that had inspired the "civilizing mission" embarked on by the European imperialist powers. It was denuded of political overtones by defining progress as the mobilization of science and technology for human improvement. And it opened space for the U.S. government and foundations to merge humanitarian sentiments with expansionist ambitions, benevolently making the world over in America's image.

The superpowers rushed to build dams, hydroelectric schemes, and model farms to curry favor with potential client states, but with little regard for local conditions. Rivers silted up, good earth turned saline, generators lay idle, and tractors bogged down in the mud or were pillaged for metal.

Eisenhower's Atoms for Peace program, announced to rapturous applause in the United Nations in December 1953, raised utopian spirits. Its aim, the president said, was to exploit the peaceful atom for agriculture and medicine and to provide energy for the "power-starved areas of the world." In August 1955, 10 years after the atomic bombing of Japan, U.S. authorities launched a major campaign to distribute nuclear reactors for research and power throughout the developing world. A huge international conference in Geneva was presided over by Homi J. Bhabha, secretary to the Department of Energy in India. "For the full industrialization of the underdeveloped areas, for the continuation of our civilization and its further development, atomic energy is not merely an aid: it is an absolute necessity," Bhabha enthused. It would enable the teeming millions in his country to "*reach a standard of living equivalent to the US level*" (Krige, 2010, p. 152, Bhabha's emphasis). Bhabha thus sanctified the work of social scientists who identified modernization with convergence on the American social model. In the late 1950s Walt Whitman Rostow, later to be a national security adviser to Lyndon B. Johnson, charted the "stages of economic growth" that every country needed to pass through to arrive at that goal. His "non-Communist manifesto" is remembered as emblematic of the ideology that welded together a diverse group of social scientists dedicated to identifying the economic, political, and cultural obstacles to the American transformative agenda so as better to eliminate them.

Demography, not a lack of atomic energy, was the greatest threat to development. It was given added urgency after the first Chinese nuclear test in 1964—in merely 15 years a backward peasant society had taken giant strides into modernity with Soviet, not American, help. The Ford and Rockefeller Foundations, strongly encouraged by the administration, pumped millions of dollars into training local officials on the ground in India to familiarize villagers with the benefits of contraception, sometimes forcibly sterilizing men and inserting intrauterine devices (IUDs) into women. An international population establishment flourished under the umbrella of the United Nations, who dispatched highly paid, jet-setting consultants to expensive hotels all over the Third World, where they blithely dispensed advice that was indifferent to the idiosyncrasies of native culture and tradition. In parallel, concerted efforts were made to engineer genetically modified, highly productive strains of wheat and rice that flourished in a wide variety of climates and soils—when nourished by fertilizer and irrigation. Impressive increases in yields of "Mexi-Pak" wheat and IR-8 rice were announced with much fanfare in 1968 as signaling the onset of an incremental, democratically supported "green revolution." Brought about by American researchers and their indigenous collaborators, it would pull the carpet from under the feet of the Red Menace.

The often brutal proxy wars in developing countries in Africa, Asia, and Latin America, inflamed by superpower rivalry and a global arms trade, contrast with the peace that reigned in Europe after 1945. The social transformations undertaken in the name of modernization in the Third World were often imposed from above and backed by force if necessary. National elites colluded in a process that selectively benefited them at the expense of a destitute and growing peasant population. Existing hierarchies in Third World countries were reinforced by the access that local elites had to resources made available by the industrialized "north." Education and training, science and technology, economic aid, and military supplies were available to the privileged few and denied to the disempowered many. Efforts to accelerate modernization from without became, unwittingly or not, enrolled in a repressive struggle for power and authority within.

Modernization, as a theory of stepwise progress toward the American social model, died with détente. Population control gradually morphed into family planning with the aim of empowering the poor, especially women, to manage their own fertility. The green revolution had patchy results. Notwithstanding its uneven record, the dream of finding a universal technological fix that can eliminate poverty throughout the world continues to fire the imaginations of presidents, pop stars, and philanthropists, spurred on by multinational corporations. Their genuine engagement is oblivious to history and will doubtless founder for ignorance of its lessons.

"Americanization." The preponderance of power in America's favor at the end of World War II, as well as the growing conviction that the nation had been called on to defend democracy wherever it was threatened, provided successive presidents with the historic and ideological legitimacy for engaging in "foreign entanglements" that were otherwise anathema to those of an "isolationist" bent. Inspired by a conception of American exceptionalism that exalted their own social and political system to the pinnacle of what was possible and genuinely convinced that the United States was the greatest force for good in history, policy makers sought to export the American way abroad. The construction of durable alliances, the modernization of systems of production, the penetration of new markets, the creation of a consumer culture, and the refashioning of social values were bundled together in a package that was lived, with varying degrees of enthusiasm, as "Americanization" by those on the receiving end. Communication technologies, including film, radio, and television, were essential to this ambitious agenda, offering the alluring prospect of a life of freedom and plenty and raising the hope that "you too can be like us." America's capacity, except at moments of intense paranoia, to show the darker sides of poverty and race relations in the country only enhanced its status as an open society and sharpened the difference with its immensely secretive and oppressive Communist rival.

The Marshall Plan, or European Recovery Program, announced by President Truman's secretary of state George C. Marshall at a Harvard commencement ceremony in June 1947, helped build what has famously been called an "empire by invitation" in a debilitated and vulnerable postwar Western Europe. It was underpinned by visits to the United States lasting from one to three months by managers and workers, engineers, and economists who were instructed in the technological and managerial demands of the "politics of productivity"—the key to peaceful labor relations, agricultural and industrial growth, and political stability. These productivity missions were later supplemented by a vast effort at public diplomacy in which every imaginable medium was used to advertise the benefits of American generosity to the participating nations. Resisted by some as a form of colonization and welcomed by others as a liberation from the cramping boredom of bourgeois class culture, the "irresistible empire," along with security guarantees offered by the United States through the North Atlantic Treaty Organization (NATO), helped to lock continental Western Europe into the American sphere of influence in one of the most volatile phases of the Cold War. As one left-wing Italian militant admitted ruefully many years later, "The American myths kept their promises and won through."

Concerns to integrate European science and technology more productively into the American research system, to mutual advantage, inspired foundations, scientific statesmen, and government agencies to raise the level and change the orientation of research and education in postwar Europe in many fields, including genetics, physics, and operations research. The transatlantic circulation of people and ideas, but also of equipment, experimental practices, and management techniques, transformed European science along American lines while also providing the conditions needed for a collaborative enterprise. By the late 1950s the United States was determined that Europe establish a solid base in science and technology to share the burden of defense. The failure of a NATO-inspired committee to establish an institution like the Massachusetts Institute of Technology (MIT) in Europe in the early 1960s, linking basic research with the needs of industry and the military, was indicative of the resistance of the intellectual and political elite to American models that ran against the grain of indigenous academic traditions—in addition to being seen in France as a Trojan horse that would exploit European ideas to the United States' advantage.

The development of the first French scientific satellite launched in 1965 with NASA's help sheds light on the multiple sites in which American practices were adopted. A young team of French researchers spent extended periods of time at the Goddard Space Flight Center in Greenbelt, Maryland, learning how to organize a large project along American lines, with a single project manager, milestones, design reviews, testing procedures, and so on. The major French aerospace company Matra abandoned its traditional hierarchical management structure for a more fluid American matrix structure that broke up work by projects and accorded considerable autonomy to each project leader. Left-wing scientists and engineers who admired Soviet achievements in space found it far more congenial to work with counterparts in the American space agency, where the openness and lack of hierarchy contrasted sharply with Soviet secrecy and the sense that one was always speaking to an intermediary, not to a responsible official. From the United States' point of view, a collaborative effort under its tutelage was an opportunity to build a research and business community that spoke the same technical language and that was organized along the same lines as their American homologues, facilitating knowledge circulation, creating new markets, and consolidating the Atlantic community. From the European point of view the standardization that went with Americanization enabled them to jump-start their exploration of space by creatively applying American practices to local needs.

The concept of Americanization is deemed by many historians to be too general and totalizing to be of much analytical value. It has the advantage, however, of alerting us to the hold that "America" had on the imagination of people all over the globe. It alerts us to the depth to which the postwar American project sought to refashion everyday social practices and values in line with those that prevailed in the United States. Navigating between the attractions of the American way and its threat to deeply ingrained customs, traditions, and values, those on the receiving end selectively appropriated, adapted, reconfigured, or simply rejected the model on offer to satisfy the specificities of particular situations. The project to refashion the world in America's image not only had to take account of the agency of those at whom it was directed. Above all, it was necessarily constrained by the stamina of local cultures.

Symbolizing. Former president George H.W. Bush characterized the Cold War as a struggle for the soul of mankind, a struggle for a way of life. Spectacular technological displays were one of the most important symbols used to demonstrate the superiority of that way of life to a public entranced by an idiom of progress founded on the mastery of nature. This faith in the transformative power of science and technology was not new to the period after 1945, of course, nor was the fusing of national prestige with awe-inspiring demonstrations of technological achievement. The giant, forty-five-foot-tall Corliss engine that powered most of the exhibits at the Centennial Exhibition in Philadelphia in 1876 was an extraordinary engineering feat. It stirred national pride and reassured an American people reconstituting its identity after a divisive civil war that they were a match for their rivals Britain and France, if not streaking ahead of them. What is different in the Cold War is the escalation of a traditional scientific and technological rivalry between nations into a rivalry between two world systems that were fundamentally incompatible with each other. The United States was not simply competing against the Soviet Union: freedom was pitted against tyranny. The success of American laissez-faire capitalism, Washington's aspirations to global leadership, and the security guarantees it gave to allies hung on the proper functioning of a complex rocket engine. The ability of Soviet state socialism to provide for the masses and to liberate them from drudgery hung on filling stores with consumer goods and cramped apartments with modern kitchens. The promise of the green revolution in agriculture to hold back the red wave that threatened to engulf the Third World by producing high-yielding versions of wheat and rice was enhanced by the sight of robust stalks in well-organized fields sprouting alongside the tangled disorder that was the hallmark of traditional agricultural production. Spectacular visual demonstrations and displays of scientific and technological ingenuity moved to center stage in the Cold War battle for hearts and minds.

Hands-on experience, along with massive media coverage and organized training, was used to market Atoms for Peace to a broad and receptive audience. At the international meeting in Geneva in 1955, a working swimming-pool-type reactor was flown in from Oak Ridge and installed in the grounds of the United Nations building, a mere mile from the city center. Public visits were interrupted every day to allow specially selected official delegates from over 70 countries to see a reactor go critical. The distinguished guests gradually removed the control rods from the pool to bring the reactor up to power by turning a handle themselves; as the device went critical the darkened room was bathed in the eerie glow of Cerenkov radiation. Posters lining the wall of the exhibit celebrated the benefits of radioisotopes produced in research reactors for agriculture, medicine, and industry. Special training programs for foreign students were arranged at Oak Ridge and at Argonne National Laboratory. Traveling exhibits, working models, films, and lectures introduced hundreds of thousands of people throughout the world to the benefits of the nuclear age, distracting attention away from the massive stockpile of lethal weapons being assembled on Eisenhower's watch.

The launch of *Sputnik* by the Soviet Union in October 1957, and the orbiting of the dog Laika in a giant capsule a few weeks later, did not pose a significant threat to American security. They were, however, dramatic displays of Soviet technological achievement and they struck a blow to American prestige and self-confidence. They raised doubts in the country's mind about the security of the mainland to surprise attack, they unsettled allies, they undermined the United States' credibility as the world's scientific and technological leader, and they enhanced Soviet claims to the superiority of Communism. The failed launch of the first American satellite in December 1957, in the presence of over a hundred newspaper and television reporters, amplified fears that the United States had fallen badly behind its Communist rival. The conquest of space was transformed from a technological and industrial challenge into a domestic political issue and a struggle for global influence that helped propel John F. Kennedy into the White House in 1961. Recognizing the impact of space spectaculars on "the minds of men everywhere" who were being called upon to choose between "freedom and tyranny," within months—and shortly after Yuri Gagarin became the first human in space—the new President asked Congress to commit the nation to a manned lunar landing before the decade was out.

More modest forms of technology were also enrolled in the psychological propaganda war between the superpowers. The "economic miracle" that got under way in Western Europe in the late 1950s, filling stores with glittering consumer goods unavailable in the Communist bloc, provided the Eisenhower administration with an opportunity to regain the ground lost in perceptions of Soviet missile and space superiority. In July 1959 an American exhibition in Moscow displayed a range of American consumer goods, including three fully equipped kitchens. One of them, General Electric's all-electric lemon-yellow kitchen, was packed with modern appliances and installed in a full-scale, ranch-style American house through which thousands of visitors circulated every day. There Vice President Richard Nixon exalted the benefits of American consumer culture in an exchange with the Soviet premier Khrushchev in an attempt both to undermine popular support for the Soviet regime and to pressure its planners to divert resources away from arms into domestic goods. The kitchen as symbol of American freedom brought Cold War technological rivalry into the gendered domestic space of the nuclear family. It presented the individual consumer, home ownership, private property, and the market economy as defining features of the superiority of capitalism over Communism.

The enthusiasm for technological prowess in the early Cold War had turned to skepticism by the 1970s. The defeat in Vietnam, urban decay and unrest, environmental damage, and the failure of modernization projects in the developing world generated a counterculture that decried technological fixes and sought more holistic approaches to social problems. Human spaceflight was criticized as a waste of scarce resources that were better spent on improving conditions on earth. The failed promise of "energy too cheap to meter," the risks of nuclear accidents, and the difficulty of disposing of nuclear waste broke the hegemonic discourse that had uncritically promoted nuclear power's benefits for two decades. Although scientific and technological preeminence was still pursued, along with constant military preparedness, it lost its role as a bearer of national pride and as a barometer of progress.

This is not to imply that the propaganda value of scientific and technological excellence lost its pertinence; on the contrary, in the early twenty-first century it was reborn as an essential asset of what is sometimes called soft power. The confrontation with the Soviet Union in the early Cold War provided an immense stimulus to sectors of American industry, notably in the domains of aerospace, computers, and miniaturization. These advances fueled the technological revolution in communications and transportation in the 1970s that were associated with the globalization of trade and the dilution of the independence of the nation state. Issues demanding state intervention—climate change, epidemics like severe acute respiratory syndrome (SARS), the international traffic in drugs, terrorism—became increasingly global in scope and required collaboration with other states, including those that were relatively small and weak. To lead from a position of interdependence requires a more nuanced exercise of power, a willingness to achieve one's foreign policy goals by cooption that secures legitimacy rather than by coercion that generates opposition. This thinking inspired policies that emphasize the possibility of using the attractions of American science and technology abroad as one of a repertoire of instruments of soft power available to secure desirable foreign-policy objectives.

The concept of soft power was given an important boost by the disastrous foreign-policy fallout of Operation Iraqi Freedom. It was alluded to by President Obama's first Secretary of State, Hillary

Clinton in the Senate hearings that preceded her nomination and institutionalized as an option in U.S. foreign policy. It starts from the premise that the attraction of American science and technology, along with its culture, ideology, and institutions, can be deployed to achieve diplomatic goals without recourse to "hard" coercive power. Indeed, a 2002 Pew Global Attitudes Project revealed that 80 percent of people in much of the world admired American science and technology compared with 60 percent who were attracted by its cultural exports and just 30 percent who favored the dissemination of U.S. ideas and customs abroad (Nye, 2004, pp. 69–72). The marketing of U.S. achievements in science and technology could still serve as an important instrument of diplomacy, but only by advertising the virtues of the American way of life using techniques quite different from those that were deemed effective in the early Cold War. This at least was the concept driving Clinton's "twenty-first-century statecraft." A section in the State Department's Office of Policy Planning sought to complement traditional foreign-policy tools by levering the networks, technologies, and demographics of an interconnected world to win hearts and minds. In 2012, the Internet and social media platforms, not nuclear reactors, space spectaculars, and modern kitchens, symbolized American freedom.

[*See also* **American Association for the Advancement of Science; American Institute of Physics; Atomic Energy Commission; Atoms for Peace; Automation and Computerization; Bush, Vannevar; International Geophysical Year; Internet and World Wide Web; Military, Science and Technology and the; National Aeronautics and Space Administration; Nuclear Weapons; Radio; Research and Development (R&D); Rockefeller Institute, The; Science; Social Sciences; Space Program; Space Science; Technology;** ***and*** **Television.**]

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John Krige

In January 2021, we began the learning journey through history with Diplomacy and Technology: A historical journey, a series of open monthly Zoom discussions on the evolution of diplomacy and technology, led by Dr Jovan Kurbalija, an expert with an academic background in international law, diplomacy, and digital technology.Â Dramatic changes, both in diplomacy and in technology, took place during this period: many countries established diplomatic services consisting of ministries of foreign affairs and professional diplomats, numerous multilateral negotiations were conducted in the post-Napoleonic Concert of Europe, and the first international organisations were established. The contributors are professors, diplomats and officials involved in international relations, coming from a wide variety of countries. The volume begins with Hon. Dr. George F. Vellaâ€™s opening address to the International Conference on Modern Diplomacy. Dr. Vella provides a general framework for discussion and identifies the main changes in modern international relations affecting diplomacy. It provides insight into several current concerns, including regional co-operation and preventive diplomacy. Dr. Vella highlights the important but often overlooked difference between diplomacy as a method Diplomacy is the chief, but not the only, instrument of foreign policy, which is set by political leaders, though diplomats (in addition to military and intelligence officers) may advise them. The purpose of diplomacy is to strengthen the state, nation, or organization it serves in relation to others by advancing the interests in its charge.Â A diplomat also has the ongoing responsibility of collecting and reporting information that could affect national interests, and is often in a good place to give advice about how the home country should react. He or she should also do their utmost to represent the views of the home government to the government of the country in which they are posted, and convince these governments to act in ways that the home government would prefer. A policy quarterly from the AAAS Center for Science Diplomacy that provides analysis and insight on the intersection of international relations, science, and foreign policy.Â The guest editors of the special issue, Future-Casting Science Diplomacy reflect on the effects that the COVID-19 pandemic has had in the relationship between science and diplomacy, and on ideas proposed by contributors to this special edition. Read More. Editorial. National Interest, Global Interest, and Science. By E. William Colglazier - 01/22/2021. The degree to which global concerns are incorporated into national aspirations becomes one of the most important factors in determining whether countries can tackle worldwide problems together. Read More. January 2021: Special Issue. Diplomacy is a fine art, heir to centuries of epochal deal making, system building, peacemaking and conflict avoidance and resolution â€“ it is, in many ways, a profession for the ages. In the minds of men and women at large, however, it is also seen as a profession conducted in rarefied environs, in dizzying ivory-towered heights, away from the hurly-burly of earthling life.Â Thus, diplomacy in the minds of those outside the foreign services and chancelleries of the world is rarely accorded the definition of a profession in the way that medicine, civil service, law or a career in the military may be regarded. For those, however, who have practiced diplomacy through their working lives, it is regarded as a transnational profession.