



PROJECT MUSE®

Alvin Weinberg and the Promotion of the Technological Fix

Sean F. Johnston

Technology and Culture, Volume 59, Number 3, July 2018, pp. 620-651 (Article)

Published by Johns Hopkins University Press



➔ For additional information about this article

<https://muse.jhu.edu/article/703142>

Alvin Weinberg and the Promotion of the Technological Fix

SEAN F. JOHNSTON

ABSTRACT: The term *technological fix*, coined by technologist/administrator Alvin Weinberg in 1965, vaunted engineering innovation as a generic tool for circumventing problems commonly conceived as social, political, or cultural. A longtime Director of Oak Ridge National Laboratory, government consultant, and essayist, Weinberg also popularized the term *big science* to describe national goals and the competitive funding environment after the Second World War. Big science reoriented towards technological fixes, he argued, could provide a new “Apollo project” to address social problems of the future. His ideas—most recently echoed in “solutionism”—have channeled confidence and controversy ever since. This article traces the genesis and promotion of the concept by Weinberg and his contemporaries. It argues that, through the concept, the marginal politics and technological confidences of interwar scientists and technocrats were repositioned as mainstream notions closer to the heart of big science policy.

Introduction

This article traces the packaging and promotion of an idea that has long been implicit in culture. Reliance upon technological solutions to address human problems is arguably a human trait, but it became a more ubiquitous aspect associated with modernity over the past century. Rapid innovation encouraged widespread appreciation of the potential of technologies to alter modern societies. This confidence, or hubris, concerning the power of technological approaches has ranged from the design of inherently safe streetcars to proposals for remediating climate change.¹

Sean F. Johnston is professor of science, technology, and society at the University of Glasgow, UK. He acknowledges gratefully the funding for this work by the British Academy under Grant SG132088. He wishes to thank Margaret Allard for helpful access to the Alvin Weinberg Papers at the Children’s Museum of Oak Ridge, Tennessee, as well as Timothy J. Gawne (Oak Ridge National Laboratory) and former colleagues Tom Row, Steve Stow, and Alex Zucker on Weinberg’s career.

©2018 by the Society for the History of Technology. All rights reserved.
0040-165X/18/5903-0004/620–51

1. Thomas P. Hughes, *American Genesis*; Sean F. Johnston, “Technological Parables and Iconic Illustrations”; Royal Society, “Geoengineering the Climate.”

While scholars and designers have both analyzed the links between invention and societal outcomes, there has been a discernable trend toward the framing and addressing of contemporary problems in narrow technological terms.² The legacy of such ideas remains current today: recent expressions of technological “solutionism” (“there’s an app for that”) echo these enduring cultural assurances.³ A seminal spokesperson for this optimistic belief was Alvin Weinberg, the longtime director of Oak Ridge National Laboratory (ORNL), who coined and popularized the term *technological fix* from the mid-1960s onward and captured these widely shared assumptions. In its simplest form, the label refers merely to the solving of a problem by means of an engineering approach; its more contentious dimension, however, was Weinberg’s claim that solutions founded on technological innovation may be innately superior for addressing issues traditionally defined as social, political, or cultural. Historians have explored twentieth-century case studies identified retroactively as technological fixes. As historian Thomas Hughes summarized from such cases, “most technological fixes leave us in a fix.” Yet, this critical judgment is unequally subscribed across the academic disciplines and through popular culture: views range from outright dismissal of this putative societal tool to optimism about timely technological solutions to human problems.⁴

I focus on the discourse about such approaches, and explore the context within which the notion of the technological fix was voiced and illustrated from the mid-twentieth century onward. Tracking the evolution of ideas by key actors and interpreters, my primary sources are the writings of, and responses to, Weinberg and his contemporaries. The shared working environments of these actors had included interwar progressive science, wartime American technology, postwar national laboratories, and subsequent science policy advising. These evolving contexts gradually altered how they envisaged the societal benefits of science. The narrative consequently entrains not just postwar scientists and engineers, but also contemporary analysts and critics of technoscience.

Weinberg had to work hard to convince his audiences (and himself) that the notion was sound and valuable as a general approach to problem-solving. Statistics about the usage of the term hint at the correlation between his active promotion and subsequent popularity of it. The rhetoric of technology as problem-solving tool rose during the late 1960s and proved to be enduring in written discourse. I argue that the embedding of technological fixes as a compact concept in modern culture is attributable to Weinberg’s unique combination of interests, skills, and career context. His activities as a networker and essayist and penchant for packaging contentious ideas

2. Lewis Mumford, *Technics and Civilization*; Jacques Ellul, *La Technique, Ou L’enjeu du Siècle*; Herbert Marcuse, *One-Dimensional Man*.

3. Trademarkia, “There’s an App for That Trademark Information”; Evgeny Morozov, *To Save Everything, Click Here*.

4. Thomas P. Hughes, “Afterword.”

JULY

2018

VOL. 59

made him an important conduit for discussions of the role of science and technology in society.⁵ Weinberg's promotion of the technological fix was positioned between, and eventually combined with, two other neologisms that have generated enduring interest. During the early 1960s, he adopted the term *big science* to frame his analysis of government-funded, nationally oriented science. And from the end of the decade, his term *trans-science* labeled problems that required social as well as scientific methods.

The present account explores how Weinberg's promotion and merging of these ideas made technological fixes alternately compelling and contentious for varied audiences. Reflecting the rhetoric of interwar and post-war technocrats, he packaged a commonplace notion and promoted it as the centerpiece of revitalized big science. His actions thereby reconfigured the overt politics and social aims of interwar scientists into a strategy of science policy. Significantly, Weinberg's exploration of these ideas has continued to evoke discussion and shaped the canon of science and technology studies and syllabuses of the history of technology over the half-century since they were coined.

Alvin Weinberg as Mid-Century Technoscientist

Born in 1915, Weinberg obtained his first two degrees in physics from the University of Chicago during the 1930s, and subsequently taught for two years at a junior college in the city. His career interests were broad, as suggested by doctoral studies in the emerging field of mathematical biology under Nicolas Rashevsky. His goal of modeling periodicities in cell metabolism was ambitious in relating the tools of physics to the living world.⁶ Through his supervisor, Weinberg developed interests in mathematical sociology and, via Rashevsky's acquaintance Alfred Korzybski, pursued studies of semantics and logic. These pursuits supported his later activities as public speaker and essayist.

Weinberg gained his substantive working experience as a physicist during the early years of World War II, directly involved in designing the first nuclear reactors for the Manhattan Project at Oak Ridge, Tennessee, and Hanford, Washington. His mentor and lifelong friend Eugene Wigner (1902–95) later recalled Weinberg as “a natural diplomat.” Wigner identified these wider competences and orientations as Weinberg's key strengths:

5. Google Books, Ngram Viewer terms *technological fix*, *technical fix*, and *technological solution* (available at <https://books.google.com/ngrams> [accessed 20 July 2015]); Jean-Baptiste Michel et al., “Quantitative Analysis of Culture Using Millions of Digitized Books.” Usage in British English rises some five years after that in the United States; German and French have no direct equivalents, using either the imported English-language *technological fix* or else the earlier and broader terms *technische Lösung* and *solution technique*, respectively.

6. Alvin M. Weinberg, *The First Nuclear Era*, 7–9.

"We set him to work on broader scientific questions. His grasp of human personality won over many doubters. He never failed us."⁷

Weinberg's links with Rashevsky and Korzybski were later to channel his first enunciation of the technological fix, but these unconventional contacts attracted the attention of postwar security officers. His interview provides a glimpse of Weinberg's "generally liberal" politics, later to be subsumed within his views on technology. He recalled his political philosophy being "flavored by the spirit that pervaded the college campus," contributing to organizations "in which there were certainly Communists . . . but after joining I somehow felt my conscience had been salved." Security officials also scrutinized Weinberg's wartime associations with groups "dissatisfied with the conduct of the [Manhattan] project." He responded that this "group of younger scientists" was concerned with "the impact of what atomic scientists were doing in the world at large." In summary, he noted, "I have been in the past, if you like, a person on the Progressive side, although, unfortunately, I seem to be getting more conservative as I grow older."⁸

Weinberg as Voice of Postwar Science

While Weinberg's social concerns mirrored those of many of his contemporaries, his postwar activities were directed toward disciplinary and career ambitions. Oak Ridge became a national laboratory in 1946, but as its technical director from 1948 on, Weinberg had to lobby actively for the facility's continued work on the design and applications of nuclear reactors, in competition with the Argonne National Laboratory near Chicago.⁹ His co-organizing of what was known informally as the "Clinch College of Nuclear Knowledge" (1946) attracted sponsorship from influential students, such as Commander Hyman Rickover, who was to foster the nuclear navy. The subsequent Institute of Nuclear Studies (ORINS, from 1947) and School of Reactor Technology (ORSORT, from 1950) predated university teaching of the subject by a decade¹⁰ (fig. 1). While operating within a strict security environment, both ORNL and ORINS were outward-looking; their staffs, students, and visitors represented U.S. companies, government services, and academic affiliations. ORINS was directed by academics from eight universities spanning not just physics and chemistry, but also biology and medi-

7. Ibid., 13; Eugene Wigner and Andrew Szanton, *The Recollections of Eugene P. Wigner*, 216–17.

8. Oak Ridge Operations Manager, "Dr Alvin A. Weinberg Security Clearance Meeting," 29 September 1948, box 14, folder 4, in Weinberg Papers, Modern Political Archives (hereafter MPA), at the Howard H. Baker Jr. Center for Public Policy, University of Tennessee.

9. See, for example, Alvin Weinberg to J. Robert Oppenheimer, letter, 6 January 1948, box 17, folder 5, in MPA.

10. Richard G. Hewlett and Francis Duncan, *Nuclear Navy*.

JULY
2018
VOL. 59



FIG. 1 Alvin Weinberg teaching at the Oak Ridge School of Reactor Technology, 1954. (Source: ORNL Photo Archives 13125.)

cine. Its lab facilities, traveling speakers, and graduate-training program disseminated atomic expertise to the first generation of postwar technologists.¹¹

Assuming overall direction of ORNL in 1955, Weinberg's management style further expanded his professional networks. He implemented an annual review system for the burgeoning departments, ranging from chemical technology to radiation biology, based on external assessors and all-lab "information meetings." His expanding contacts led to reciprocal arrangements, including roles in external reviewing of academic departments and membership on advisory committees of organizations, such as the National Academy of Sciences (NAS). By mid-career, Weinberg's committee work and handpicked review panels provided a rich network of contacts. As his status grew, he sponsored those he admired for membership in the Washington, D.C. Cosmos Club, which promoted science, literature, and art for the American intellectual elite. Weinberg consequently was able to survey not just the nascent field of nuclear science and engineering, but also the changing terrain of government-funded science via the perspectives of other disciplines. And his growing predilection for public speaking provided a platform for his evolving views about the integration of technological innovation with the goals of modern U.S. society.¹²

11. Sean F. Johnston, *The Neutron's Children*.

12. Alex Zucker interview.

Touchstones for Weinberg's Ideas

Both in his personal papers and autobiographical publications, Weinberg acknowledged his reliance upon peers to assess and refine his notions, a strategy that also underlay his information-meeting approach to ORNL's management. His ideas typically were shaped by a sequence of personal insights, one-to-one soundings with colleagues, and trial speeches to diverse audiences. The role of mentors and confidantes was crucial to these iterations. While these informal advisors shifted and expanded throughout his career, only a handful contributed to what was to become the *technological fix*.

The earliest and most enduring of these advisors was Wigner, a physicist. He had been Weinberg's immediate superior during the Manhattan Project, responsible for designing the first pilot-plant nuclear reactor at Oak Ridge, and the mammoth plutonium-production reactors at Hanford. After the war, Wigner served as the research director of ORNL, a post he passed on to Weinberg two years later. A political conservative, Wigner railed against lab bureaucracy and positioned himself outside the mainstream of U.S. government policy by lobbying for civil defense measures alongside nuclear weapons.¹³

Weinberg's public adoption of his mentor's views was illustrated by his serving on the President's Science Advisory Committee (PSAC) on civil defense during the Eisenhower and Kennedy administrations, and implementing a civil defense research project at ORNL in 1964, with Wigner at the helm. This project is notable in being the only example in Weinberg's career in which social measures were to be vaunted over technological approaches. Aiming to look at civil defense "from the broadest possible viewpoint," it would consist initially of "about a dozen mature natural and behavioral scientists . . . to develop a coherent picture of the whole Civil Defense problem." The project led to the employment of sociologists at ORNL and the opportunity to directly inter-compare the social science and engineering approaches for solving societal problems.¹⁴

Harvey Brooks was Weinberg's second most influential guide during the 1960s. The dean of Engineering and Applied Physics at Harvard, Brooks had received his education and experience during World War II. Like Weinberg, he had participated in designing postwar nuclear reactors and developed an interest in applying scientific expertise for policymakers. Weinberg and Brooks first interacted via an ad hoc committee on reactor policies and pro-

13. See, for example, Wigner and Szanton, *The Recollections of Eugene P. Wigner*, 287–96; Alvin M. Weinberg, *Reflections on Big Science*, 139–40.

14. Alvin Weinberg to H. L. Brode, letter, 1 April 1965, "Civilian Defense" file, cabinet 2, drawer 4, in Weinberg Archives, Children's Museum of Oak Ridge (hereafter CMOR). Weinberg's sister was also a sociologist, at the University of the Pacific in Stockton, California.

JULY

2018

VOL. 59

grams for the Atomic Energy Commission (AEC) in 1958, and later through NAS's Committee on Science and Public Policy (COSPP), which Brooks chaired.¹⁵ As his obituary put it, Brooks was interested "in the sociopolitical context of science," seeking "to understand both the human and the more intellectual dimensions of a rational society," with science being "driven by societal needs." Weinberg was to credit Brooks with clarifying his ideas about technological fixes as a positive rational route for society.¹⁶

Two other scholars had a role in nurturing Weinberg's ideas about science and society. The first was Yale historian and bibliometrist of science Derek de Solla Price. Weinberg first encountered de Solla Price's writings in 1961 in the midst of developing his critique of big science and recommended him as a forecaster to a presidential advisor.¹⁷ In committee work and his first public exposure via speeches and newspaper articles, Weinberg had been reflecting on the implications of government-funded science, and particularly on the challenges of adequately funding the explosively expanding variety of worthy projects. He had already courted controversy by calling for the prioritization of big science having demonstrable social impact, notably questioning the value of the space program instead of medical research to discover more effective treatments for cancer.¹⁸

De Solla Price's historical extrapolation of scientific activities appeared to support Weinberg's conviction that the trajectory of science had to change—and quickly. He struck up a correspondence with the historian, with topics ranging from the resource constraints limiting scientific expansion to the deterioration of scientific writing style, musings that were to inform Weinberg's subsequent speeches, essays, and committee work over the following five years. Weinberg discovered that his own views, founded on a career in engineering and administration, accorded closely with those of the humanities scholar. The two organized a six-week summer institute at ORNL on "Humanistic Discussions in Science" in 1963, teaching alongside Robert Oppenheimer, anthropologist Margaret Mead, and historian of technology Melvin Kranzberg. Weinberg's writings on big science were

15. See "Harry D. Smyth" file, cabinet 14, drawer 4, in CMOR.

16. Lewis M. Branscomb, "Harvey Brooks"; see, for example, Harvey Brooks, "The Evolution of U.S. Science Policy."

17. Alvin Weinberg to Jerome Weisner, memorandum, 26 June 1961, "De Solla Price correspondence," cabinet 3, drawer 4, in CMOR. Wiesner (1915–94) was an MIT professor of engineering and the chair of President Kennedy's Science Advisory Committee.

18. "Cure Cancer?"; Alvin M. Weinberg, "'Big Science': A Liability?," "Big Science—Marvel or Menace?," and "Big Science, Big Technology, and Social Organization," American Chemical Society Southeastern Regional Meeting, Gatlinburg West Virginia, 1 November 1962, Box 85, folder 15, in MPA.0332; Gene Bylinsky, "Is 'Big Science' Headed for 'Big Trouble'?" Weinberg's speech ("Impact of Large-Scale Science on the USA") was described as "frank and courageous" by his local newspaper, and in a sequence followed by most of his subsequent public addresses, it was published as an essay (Weinberg, "Impact of Large-Scale Science in the U.S.").

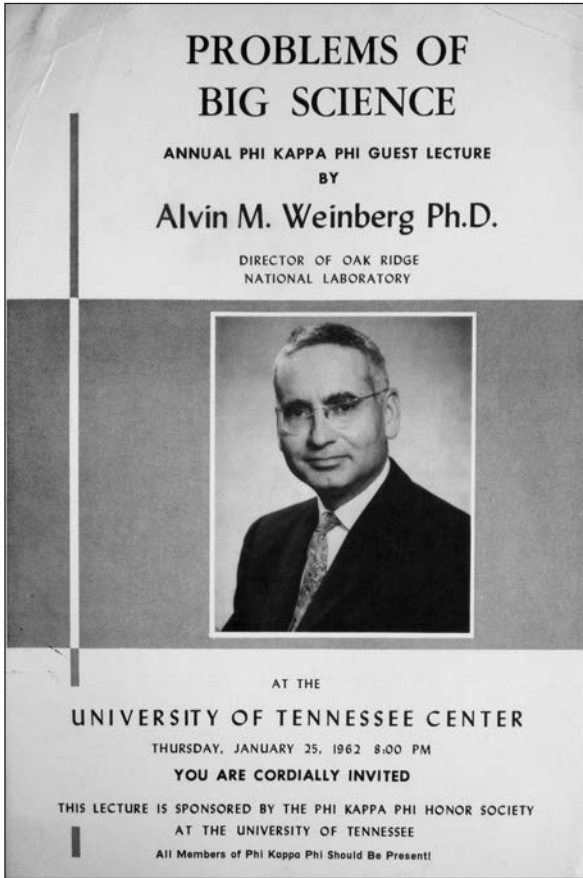


FIG. 2 1962 poster for a public lecture by Alvin Weinberg on the challenges of “Big Science,” a term he popularized. (Source: MPA Box 14, folder 27. University of Tennessee, Knoxville—Libraries.)

mirrored by de Solla Price’s book quantifying its historical dimensions (fig. 2). Allied with this scholarly backup, this first public foray into science policy yielded favorable reviews from the press and encouraged further provocative reflections on science and society. Indeed, he was to confide that “writing controversial essays” about big science was “a risky business,” and that he was “reconciled to reading violent reviews from my colleagues who differ fundamentally with my viewpoint.”¹⁹

19. Derek de Solla Price, “The Acceleration of Science,” “The Beginning and the End of the Scientific Revolution,” and *Little Science, Big Science*; Weinberg, “Impact of Large-Scale Science in the U.S.” and *Reflections on Big Science*; Alvin Weinberg to Derek de Solla Price, letter, 29 May 1963, “De Solla Price” file, cabinet 3, drawer 3; Alvin Weinberg to Lord Snow of Leicester, letter, 24 August 1965, “Chron 1965-2” file, cabinet 5, drawer 4. Both letters in CMOR.

JULY
2018
VOL. 59

Weinberg's other significant adviser was Emmanuel Mesthene, the director of Harvard's Program on Technology and Society, which had been set up with IBM funding in 1964. Mesthene himself was an academic philosopher and former RAND Corporation researcher, and like Weinberg was confident of the role of technology in shaping the future both in terms of improved social structures and more effective political initiatives. Brooks was a contributor to his Harvard program, and both Mesthene and Weinberg were members of Brooks's COSPUP. Mesthene was a sounding board for Weinberg's private musings on technological fixes from 1965, and was later to publish the first book anthology that included Weinberg's initial writing on the subject.²⁰

Gestating the Technological Fix

The nascent idea of the technological fix gestated in an environment that provided attention and considerable admiration for Weinberg's views. His public addresses during the early 1960s focused on two favorite topics. First was his teasing out of the implications of big science. As he reiterated, the new scale of research would demand prioritized government funding, but "technological gigantism" would also require scientists to be more socially aware and responsible about the consequences of applications, and to consider the potential for accidents. Weinberg drew on contemporary critiques to nuance his own messages. These updated the warnings of John von Neumann about large-scale technologies, cited the work of biologist Rachel Carson on the ecological catastrophe of DDT, and chimed with ideas expressed by Hans Bethe scarcely a month earlier.²¹ Weinberg's second hobbyhorse was scientific literacy, which ranged from criticisms of jargonistic technical writing to calls for better science education in schools. He was also becoming more conscious of the power of language and presentation. He counseled an acquaintance in the Office of Science and Technology on coining catch phrases, suggesting that a catchy slogan could suggest the linkage of ideas, even if it did not reflect reality. Through these avocational ventures he attracted positive mentions from scholars in the humanities and social sciences, as well as praise from newspaper editorialists.²²

20. Emmanuel G. Mesthene, "On Understanding Change" and "How Technology Will Shape the Future."

21. John von Neumann, "Can We Survive Technology?"; Rachel Carson, *Silent Spring*; Hans Bethe, "The Social Responsibilities of Scientists and Engineers"; Alvin M. Weinberg, "Technological Gigantism and the Social Responsibility of the Nuclear Scientist: Presentation before Brookings Institution, Advanced Study Program, 12 February 1964," Box 114, folder 19, in MPA.0332; Alvin Weinberg to Hans Bethe, letter, 9 March 1964, "Chron 1964-69" files, cabinet 5, drawer 4, in CMOR.

22. Weinberg recommended the catchphrase "Water for Peace" to describe nuclear desalination research, modeled on the earlier phrase "Atoms for Peace" coined by the Eisenhower administration—"a phrase that has been widely used and which has

From the early 1960s, his views on big science provided Weinberg with a platform for greater influence. His authority as director of a national lab allowed a degree of outspokenness and favored his expanded public speaking and press coverage; work in advisory committees encouraged his musings on the role of science in society; and, interaction with a spectrum of scientists and scholars drew him toward what he later summarized as interest in the “the philosophy of science and the government of science.”²³ Further networking accentuated Weinberg’s confidence. He spent February 1966 on sabbatical at the University of California at Santa Barbara to prepare a collection of his essays that were later published as *Reflections on Big Science*. While there, he wrote that “I became more and more involved with various segments of the faculty—in particular, the Philosophy, Engineering, Biology, and Physics Departments . . . a sort of roving critic who was willing to express ideas . . . the University got its money’s worth out of my stay.” And there he encountered other forthright scholars, notably philosopher Garrett Hardin, later the author of provocative environmental essays.²⁴

Specific events further stimulated Weinberg to focus his ideas about technological solutions for societal problems. He attended the Second Pugwash Conference on Science and World Affairs in 1958, where he renewed contact with freethinkers like Leo Szilard, but also made new acquaintances with Soviet counterparts, such as Alexander Topchiev—both of whom were founder-organizers. The experience may have inspired Weinberg’s first publicly expressed views linking technology to social consequences: a 1960 newspaper interview about the products of the national labs. Military technologies, he suggested, could ensure political stability. This commonplace idea—widely shared if seldom stated compactly—was successively sharpened as Weinberg identified more examples.²⁵

The earliest and arguably most contentious such case concerned the Watts riots in August 1965. Harsh police treatment of an African-American motorist had led to community outrage in the Los Angeles neighborhood and a week of public unrest, arson, and looting, quelled at great cost in lives and property by the California National Guard.²⁶ Two days after the

brought prestige to our country even if it hasn’t brought peace to the world” (Alvin Weinberg to D. Z. Beckler, letter, 22 September 1965, “Chron 1965-2” file, cabinet 5, drawer 4, in CMOR. The press praise includes “The University and Society,” *New York Times*, 10 August 1965.

23. Alvin Weinberg to E. Garfield, letter, 26 January 1967, “Chron 1967-1” file, cabinet 5, drawer 4, in CMOR.

24. Alvin Weinberg to E. W. Morehouse, letter, 15 March 1966, and Weinberg to Garrett Hardin, letter, 25 March 1966, both in “Chron 1966-1” file, cabinet 5, drawer 4, in CMOR; Garrett Hardin, “Lifeboat Ethics.”

25. M. W. Newman, “Calls Dread of the Atom Bar to War.”

26. For a contemporary account from the *Los Angeles Times*, see Jerry Cohen and William S. Murphy, *Burn Baby Burn!*

JULY
2018
VOL. 59

riots ended, Weinberg wrote to an influential contact, Donald Hornig, who was a special assistant to President Johnson for science and technology. In thinking about the riots, Weinberg said that “I began to wonder whether there was any cheap engineering fix which was likely to reduce the probability of their occurrence at least for a sufficient time so that more profound social changes could have a chance to improve the situation permanently.” He suggested that “the clue to the engineering fix comes from the observation that the riots seem to come at the hottest, most uncomfortable time of the year,” and recommended using anti-poverty funds or money from a projected low-cost housing bill “to air-condition slum dwellings”:

Air conditioning plus television is almost a sure-fire bet for this purpose. I realize that such an approach to the solution of a social problem of immense proportion sounds awfully pat or even cynical or frivolous. Yet, I think it deserves serious thought, since in some sense it goes directly to one of the roots of the trouble—personal discomfort.²⁷

Four days later he wrote to John McCone, the former head of AEC, director of the CIA during the Kennedy administration, and currently chair of the riot investigation committee in California. Weinberg again pitched “a sort of ‘engineering’ approach to a partial solution to the problem—that is, simply, provide air conditioners in slum dwelling areas,” and estimated the cost as \$40 million for some 150,000 dwellings.²⁸

Whether the letters’ recipients judged “personal discomfort” as important a root as rioters’ anger about endemic racism, poverty, lack of opportunity, and self-control was moot; no written responses are extant. Weinberg nevertheless more cautiously pursued the idea with Mesthene that autumn. “I am increasingly impressed with what I call the ‘Cheap Technological Fix’ as a means of circumventing social problems,” he began, and “a somewhat fanciful [fix] had occurred to me reading about the Los Angeles race riots”:

Someone showed me Huntington’s correlation between the incidence of hot weather and race riots in India, and this immediately suggested that providing air conditioners . . . might considerably reduce the probability of race rioting. Admittedly this is a superficial and possibly heartless approach to the problem; yet it has the advantage that it just might work.²⁹

27. Alvin Weinberg to Donald F. Hornig, letter, 19 August 1965, “Chron 1965-2” file, cabinet 5, drawer 4, in CMOR.

28. Alvin Weinberg to John A. McCone, letter, 23 August 1965, in *ibid*.

29. The “someone” providing the Ellsworth Huntington reference, *Civilization and Climate*, was likely Harvey Brooks. Weinberg recommended him to Mesthene as being “a superb person to advise you about the validity of the idea,” and subsequently highlighted Brooks’s role in shaping it during their conversations between Boston meetings.

In the letter, Weinberg introduced two further examples of “cheap technological fixes” to Mesthene. The first concerned intrauterine devices (IUDs) for birth control. He suggested that “before the ring was invented, birth control was a desperately complicated social problem—its solution required convincing many, many individuals to change their habits and their outlook,” but that the IUD “greatly simplifies the matter [by] drastically reducing the daily motivation” needed for birth control.

Similarly, he identified nuclear weapons themselves as a cheap technological fix. “Before the H-bomb,” Weinberg noted, “the problem of war was largely viewed as being insoluble unless we changed ‘human nature,’ [but] by exploiting the crassest notion of self-preservation, the H-bomb offers a quite different ‘solution’ to the problem of war than the whole Judeo-Christian tradition teaches is possible.” He mused enthusiastically that such fixes could motivate an evolution from social problem-solving toward technological methods, and recommended it as a line of inquiry for Mesthene’s new Program on Technology and Society: “So to speak, to push the theme to its illogical end, one can ask ‘will technology make social science obsolete?’—i.e. can a cheap technological fix be developed for every social problem that short-cuts and makes irrelevant the issues of human conflict that underlie the problem as traditionally viewed?”³⁰

Weinberg’s hopes thus went far beyond the stop-gap of literally cooling down ghetto tensions to provide time for thoughtful social solutions; they suggested long-term technological interventions that *bypassed* sociological approaches, public education, political negotiation, and indeed religious and moral teachings. And Weinberg’s example of the IUD for birth control (his wife was active in the Planned Parenthood movement) hinted at a further quality of cheap technological fixes: they might work best when shifting power toward technologist problem-solvers and away from more culturally bound recipients. Unlike the daily personal regimen of the recently introduced birth-control pill, IUDs required infrequent attention though always in association with a medical authority. Such examples evade labeling as either naïve or glib; instead, I would suggest that they illustrate strong faith in rational problem-solving and attention to aspects amenable to rapid improvement. He was pleased to find that the idea “rang a bell” with Mesthene and, while claiming not to have “the time or knowledge to push the matter,” soon invited him to Oak Ridge and the Cosmos Club.³¹

The second timely trigger for Weinberg’s private reflection about fixes

See Alvin Weinberg to J. Lederberg, letter, 24 March 1969, “Chron 1969” file, cabinet 5, drawer 4, in CMOR; and Weinberg, *The First Nuclear Era*, 150.

30. Alvin Weinberg to Emmanuel G. Mesthene, letter, 19 August 1965, “Chron 1965-2” file, cabinet 5, drawer 4, in CMOR.

31. Alvin Weinberg to Emmanuel G. Mesthene, letter, 16 November 1965, in *ibid.*; Weinberg to Mesthene, letter, 1 February 1966, “Chron 1966-1” file, cabinet 5, drawer 4, in CMOR.

was Ralph Nader's campaign for automobile safety.³² As he intimated in a "fan letter," Weinberg had been struck by Nader's avowal on *Meet the Press* of being "interested in remedies, not causes." Weinberg identified his own interest in "the broader question (of which auto safety is one instance)" and enclosed the text of "a couple of talks on the subject":

JULY
2018
VOL. 59

I mention your approach to auto safety as an instance of technology circumventing the social and psychological aspects of problems that are normally thought of as primarily social rather than technological. I originally gave the talk with a bit of tongue-in-cheek, but as I see the logic of your approach to auto safety, I begin to think that technology can replace social engineering to a much greater extent than I had suspected.³³

Weinberg had discussed the campaign with Nader's sister Claire, an ORNL sociologist whom he met regularly as part of the lab's civil defense project. His "talks" were two high-visibility speeches, which suggest Weinberg's evolving confidence in the technological fix. The first had been conceived in February 1966 for a lecture in memory of Korzybski. Presented that April with an introduction by Wigner, the speech was titled "Will Technology Replace Social Engineering?" The second, six weeks later, was his last-minute choice for an alumni-award speech at the University of Chicago and more diffidently titled "Can Technology Replace Social Engineering?"³⁴

While Weinberg circulated his University of Chicago speech among his acquaintances, he also actively sought its publication. In essay form, this technological fix speech was reprinted in no fewer than seven periodicals, ranging from journals of behavioral science to space engineering, over the following year, most prominently in the *Bulletin of the Atomic Scientists*.³⁵ More targeted variants of the essay informed subsequent speeches

32. Ralph Nader, *Unsafe at Any Speed*.

33. Alvin Weinberg to Ralph Nader, letter, 7 June 1966, "Chron 1966-2" file, cabinet 5, drawer 4, in CMOR.

34. Alvin Weinberg to C. S. Read, letter, 2 February 1966, "Chron 1966-1" file, cabinet 5, drawer 4, in CMOR; Weinberg, "Will Technology Replace Social Engineering?" Fifteenth Annual Alfred Korzybski Memorial Lecture, Harvard Club of New York, 29 April 1966, Box 118, folder 3, in MPA.0332; "Can Technology Replace Social Engineering?" University of Chicago Alumni Award speech, 11 June 1966 (emphasis added) Box 88, folder 7, in MPA.0332.

35. *Oak Ridge National Laboratory News; Scientific Research; University of Chicago Magazine; Bulletin of the Atomic Scientists; Air Force and Space Digest; American Behavioral Scientist; and Chicago Jewish Forum*. The unusually wide dissemination of the essay owed much to Weinberg's active efforts to publish the text as quickly as possible and to receptive editors. See, for example, Alvin Weinberg to G. Gordon, 6 July 1966, and Weinberg to E. Rabinovitch, 5 August 1966—letters, both in "Chron 1966-2" file, cabinet 5, drawer 4, in CMOR.

and articles. Weinberg focused specifically on the political dimensions in late 1966 by exploring how technology could stabilize international relations. He also sought more popular venues for his message, ranging from his local newspaper to the *Los Angeles Times*. Weinberg's audiences grew correspondingly: that autumn, he fielded feedback from a local minister, a law professor, and a medical administrator for the United Mine Workers.³⁶ He evidently felt that the concept was a matter of common sense, yet elusive to pin down. To Brooks he confided his aim to find a general method of identifying technological fixes: "It would be a neat trick if the social problems could be converted into technological problems as, for example, Ralph Nader is converting the problem of auto safety."³⁷

Precursors

Others had sought the magician's trick of transforming the social into the technical realm. Brooks was probably responsible for pointing Weinberg to the publications of Richard Meier. Meier (1920–2007), later described by Weinberg as a "professor of everything," was in fact a wartime research chemist who turned to investigating technological solutions to postwar urban problems³⁸ (fig. 3). Developing his ideas during a Fulbright Fellowship in the postwar UK, he conceived technological means of tackling problems consequent to poverty, social organization, and city infrastructure. In his first book in 1956, Meier explored technology as a means of providing "realistic utopias . . . consonant with the resources at the disposal of society."³⁹ Like Weinberg, he was a technological optimist, but oriented explicitly toward planning technological systems to reduce inequity and yield wider societal benefits.⁴⁰ Weinberg soon discovered the pertinent echo of his own views in Meier's writing. Discussing social problems, Meier observed that "[m]ost people would instinctively exclude the scientist and the technologist in the search for solutions. Yet, in many instances, a social problem can be restated so that it is also a scientific or an engineering problem that is not only researchable, but soluble!"⁴¹ Writing that

36. "Weinberg Touts 'Technological Fixes' to Stabilize World"; Alvin M. Weinberg, "Can Technology Stabilize the World Order?" and "Is Technology the Answer to All Our Problems?" Alvin Weinberg to J. E. Spicer, 22 November 1966; Weinberg to J. Mayda, 9 December 1966; and Weinberg to J. D. Winebrenner, 23 December 1966—letters, all in "Chron 1966-2" file, cabinet 5, drawer 4, in CMOR.

37. Alvin Weinberg to Harvey Brooks, letter, 17 June 1966, "Chron 1966-2" file, cabinet 5, drawer 4, in CMOR.

38. Stephen H. Stow, "An Interview with Alvin Weinberg."

39. Richard L. Meier, *Science and Economic Development*, 226.

40. Richard L. Meier, *Modern Science and the Human Fertility Problem and Planning for an Urban World*.

41. Meier, *Science and Economic Development*, 139.

JULY
2018
VOL. 59



FIG. 3 Richard L. Meier circa 1970, the first academic promoter and analyst of technological fixes before the term was coined by Alvin Weinberg. (Source: Courtesy of photographer Thomas Whitmore. Reprinted with permission.)

“this is very much in agreement with my current views,” Weinberg invited him to lecture at Oak Ridge, an offer that Meier apparently never took up.⁴²

Nader responded positively to Weinberg’s essay: “the points and address which you enclosed were rapidly absorbed.” He invited Weinberg to a conference on “Unreported Problems” and “a panel on non-technical obstacles to innovation,” in which “the key strategy of the technological fix” would be discussed. Like Brooks, Nader traced Weinberg’s notions to antecedents: “The illustrations of the remedial ‘fix’ have been with us for years everywhere, from the automatic coupler on the railroads to a stairway railing, to a machine guard. Now, when it comes to the 60 year old, man-machine relationship of driver and car, the idea has to be presented as if it is *de novo*.”⁴³ Nader’s examples were in fact remarkably similar to those cited in speeches and literature by American technocrats from the 1920s through the ’60s. The speeches and writings of its founder, autodidact engineer Howard Scott (1890–1970), and the *Technocracy Study Course*, written by geologist cofounder Marion King Hubbert (1903–89), had discussed examples of guard rails and doors on trams and trains, machine guards on factory equipment, and even rational road design and lighting to direct human behaviors without the need for fines, rules, or training. After their first brief fame during the early 1930s, the technocrats’ rhetoric again came to public attention via well-publicized postwar rallies, road tours, and membership drives through the 1950s.⁴⁴ There is no evi-

42. Alvin Weinberg to Richard L. Meier, letter, 19 December 1966, “Chron 1966-2” file, cabinet 5, drawer 4, in CMOR.

43. Ralph Nader to Alvin Weinberg, letter, 22 October 1966, “Nadar” file, cabinet 7, drawer 1, in CMOR.

44. See, for example, Charles H. Wood, “The Birth of the Technical Alliance”;

dence that Weinberg had encountered technocracy literature before he formulated his notions of the technological fix, but he had met and corresponded with Hubbert about energy matters in 1961, who later noted the similarity of their views.⁴⁵

Merging Technological Fixes with Big Science

As with his promotion of previous issues, Weinberg interwove his public addresses and articles with writing for advisory committees. His first notions of big science coincided with membership on an NAS committee examining “Basic Research and National Goals.” The NAS advised on the level of government support needed to maintain an international lead, and the current balance of support to various fields—topics in which Weinberg’s big science musings fit right in.⁴⁶ Through 1966 he dedicated his spare hours to preparing an essay collection, *Reflections on Big Science*, in which the relationship between social and technical problem-solving mooted the concept of technological fixes. As one reviewer noted, “these reflections represent years of essaying answers to fundamental questions about the changes in science—changes not only in content alone but in scale and scope, in method and purpose.”⁴⁷

A subsequent NAS study chaired by Brooks on technological progress incorporated Weinberg’s further thoughts on technological fixes, allied with a shifted focus toward “interdisciplinary, mission-oriented laboratories and the new concern with social problems.” This “extension and elaboration of views” from his University of Chicago speech developed the notion significantly: he now conceived a reconfiguration of labs like ORNL into “socio-technical institutes” devoted to solving national problems via a combination of technological fixes and social research.⁴⁸

Its opening salvo was bold: “a technological invention is easier to make and put into use than is a social invention.” If technological components in social problems could be defined, “if, for example, they find their expression in the invention of a single device—then . . . the underlying social problems become more tractable.” Weinberg rehearsed the now familiar examples of car and traffic safety and the H-bomb as peacekeeper, but also

Howard Scott, “Public Lecture by Howard Scott” and “Design, Direction or Disaster”; and Marion King Hubbert, “Lesson 22.”

45. King Hubbert to W. T. Thagard and Alvin Weinberg, letter, 19 September 1961, “Hubbert” file, cabinet 6, drawer 1; Hubbert to Weinberg, letter, 31 March 1967, “Chron 1967-1” file, cabinet 5, drawer 4, both in CMOR.

46. Alvin M. Weinberg, “Basic Research and National Goals” and “A Department of Science.”

47. Weinberg, *Reflections on Big Science*.

48. Alvin Weinberg to Harvey Brooks, letter, 3 March 1967, “Chron 1967-1” file, cabinet 5, drawer 4, in CMOR; Alvin M. Weinberg, “Social Problems and National Socio-Technical Institutes,” 415.

JULY
2018
VOL. 59

identified fossil fuels and nuclear desalination as technologies having dramatically negative and positive social implications, respectively.⁴⁹ As to “problems that are much more obviously social and that seem to have very few technological components such as crime, or race relations, or urban development,” he argued that technical solutions were within grasp. Citing Meier, Weinberg observed that many problems traditionally viewed as primarily social possess strong technological components. For example, electronic burglar alarms “would considerably increase the risk a prowler would have to accept in accosting his intended victim,” even if they did “nothing to eliminate the causes of crime: poor environment, poverty, broken homes, and the like.”

Such “technological palliatives, or even ‘fixes’” could be sought more systematically, he argued. “There is a severe mismatch between the Government’s magnificent scientific resources for attacking *technological* problems and the seeming *social* character of the problems that the Government is trying to solve.” Weinberg consequently proposed that “the country’s technologically oriented . . . laboratories and hardware contractors [be] modified and mobilized to find partial solutions to deeply important social problems.”⁵⁰ His contribution to the NAS report was reproduced in *ORNL Review* and distributed to his peers, including a social sciences academic at Harvey Mudd College with the “hope that your freshmen will tear it to pieces as only 19 year olds can.” The recommendations were championed by Tennessean Senator Howard Baker Jr., who sought a Senate select committee on technology and the human environment and “a dialogue between social scientists, technologists, and other experts about national problems.”⁵¹

Weinberg’s new focus confronted national policy directly and proffered technological fixes as a political tool. He lobbied the Johnson administration for air-conditioned low-income housing, garnering coverage in the *Washington Post*. And writing more ambitiously to the Department of Defense in early 1967, he suggested constructing a wall between North and South Vietnam in order to reduce incursions from the north. Weinberg noted that ORNL “had done a little thinking about it [and] would be ready to mobilize around the problem.” Soundings among his peers evidently tempered his confidence, however; the following month, he backed away from an article on the idea, describing the notion as “very amateurish” and deleted the example from the draft of a forthcoming college commencement address.⁵²

49. Weinberg, “Social Problems and National Socio-Technical Institutes,” 417.

50. *Ibid.*, 416.

51. *Ibid.*; Alvin Weinberg to W. H. Davenport, letter, 14 June 1967, “Chron 1967-1” file, cabinet 5, drawer 4, in CMOR; Edward Kimbrell, “Weinberg-Baker Propose Socio-Techno Institutes.”

52. Alvin M. Weinberg and James C. Bresee, “On the Air-Conditioning of Low-Cost Housing,” “Chron 1968-1” file, cabinet 5 drawer 4; “NCHA Plans Public Housing Air-Conditioning.” Alvin Weinberg to J. S. Foster Jr., letter, 7 March 1967; Weinberg

In its place, Weinberg offered an example that more potently illustrated the role of renewed national labs in solving socioeconomic problems: the development of nuclear agro-industrial complexes. The concept owed much to Meier's work a decade earlier, which illustrated how complex technological systems could improve underdeveloped regions. It also evoked the experience of the state of Tennessee, home to Weinberg and his ORNL: the Depression-era Tennessee Valley Authority (TVA) project ambitiously had combined hydroelectric dams, waterway diversions, and distribution networks to provide irrigation, flood control, and electricity—indeed, the electricity that later powered the uranium-separation plants at Oak Ridge itself.

Weinberg envisaged vast nuclear-power stations as the hubs of such networks. They would generate copious electrical power to desalinate seawater, energize irrigation systems, manufacture fertilizer and heavy chemicals, and provide the motive force for an industrial society. The idea shifted the technological fix from the notion of a short-term repair to a tool of international development, as Weinberg argued at a Swedish conference.⁵³ It also updated and generalized an ORNL research project spawned by the Eisenhower administration's "Atoms for Peace" initiative of the late 1950s to investigate nuclear desalination plants for supplying water to arid regions in the United States. (Small nuclear desalting facilities had been operated by the Soviet Union since 1964, and later were also built by Japan and India.) Weinberg's vision consequently pulled together his experience as lab director, essayist, and government advisor. As he later recalled, "I regarded nuclear energy as a magical panacea . . . [with] seemingly unlimited possibilities . . . for solving social problems, poverty, ethnic rivalries exacerbated by quarrels over water, even war itself."⁵⁴

The initiative, developed principally by Lewis Strauss and Weinberg in collaboration with Israeli and Egyptian engineers, was not pursued by the Johnson administration. Weinberg subsequently declined an offer by Strauss to join a Richard Nixon campaign group, because he "assiduously tried to separate [his] personal political beliefs from public statements." Instead, he sent a briefing paper to each of the major presidential candidates describing agro-industrial complexes as the "Apollo of the '70s." He argued that federal funding was crucial for such technology projects that were "too expensive, too long-range and too important for the long-term future of the country to be supported by the free market." From technologist-

to W. P. Steven, letter, 29 April 1967; and Weinberg, "Agenda for the Seventies," "Chron 1967-1" file, cabinet 5, drawer 4—all in CMOR.

53. Alvin Weinberg, "The Agro-Industrial Complex" (first draft), 13 August 1967, "Chron 1967-2" file, cabinet 5, drawer 4, in CMOR.

54. Alvin M. Weinberg, "Technological Fixes, Carbon Dioxide and Water (Manuscript, 24 Mar 1994)," box 114, folder 24, in MPA.0332; Dwight D. Eisenhower and Lewis J. Strauss, "A Proposal for Our Time."

administrator and consultant, Weinberg had moved to a position of direct political lobbying.⁵⁵

Contemporary Critiques and Deft Defenses

JULY
2018
VOL. 59

Weinberg's networking, speeches, and widely reproduced essays garnered varied attention for technological fixes. Significantly, his closest confidantes—Wigner, Brooks, and de Solla Price—never adopted the term, and Mesthene limited his public acknowledgment to a 1967 anthology that included Weinberg's University of Chicago essay. By contrast, Weinberg's direct superior, AEC director Glenn Seaborg, provided an early endorsement, and the University of Chicago sociologist and editor of *Minerva* Edward Shils built an enduring relationship, drawing on Weinberg as consultant, referee, reviewer, and article-provider.⁵⁶

Weinberg's rhetoric provoked and yet attracted audiences, who appear to have found the notion of technological fixes variously compelling, naïvely confident, or threatening. The earliest disciplinary criticism came from scholars who disparaged Weinberg's phrase "social engineering"—a term he had employed in correspondence from at least early 1966. Among the first was a representative of the American Geophysical Union, who identified it as an aspersion on engineers. Weinberg replied to suggest a different target: "[T]he whole burden of my article was to point out that the technologist—i.e. the real engineer—has much to offer in the solution of social problems that are usually considered to be the province of those who try to *manipulate* social behavior; it is the latter whom I call 'social engineers.'"⁵⁷

This reduction of the social sciences and traditional humanistic approaches for problem-solving, including education, religion, and politics, to mere "engineering" and "manipulation" challenged his counterparts in those fields. Even worse, Weinberg had repeatedly dismissed such techniques as inferior to technological innovation. Sociologist of science Bernard Barber dubbed Weinberg (and his ally Brooks) a "gifted amateur" and "scientist-sage," but argued that "science policy studies need to keep close contact with the fundamental social science disciplines, with their best theories and their best research methods and findings."⁵⁸

55. Alvin Weinberg to Lewis Strauss, telegram, 6 September 1968; and Weinberg, "Memorandum on Some Technological Possibilities for the Seventies sent . . .," 29 August 1968—both in "Chron 1968-2" file, cabinet 5, drawer 4, in CMOR.

56. Emmanuel G. Mesthene, ed., *Technology and Social Change*; Glenn Seaborg, "Toward a Science of 'Techumology.'" Weinberg published some twenty-three articles, reviews, and editorials in *Minerva* from 1962 to '96; in 1983, he and Eugene Wigner were instrumental in arranging for funding that allowed the journal to continue publication. On Weinberg's retrospective views, see his "Edward Shils and the 'Governmentalization' of Science."

57. Alvin Weinberg to W. E. Smith, letter, 31 January 1967, "Chron 1967-1" file, cabinet 5, drawer 4, in CMOR (emphasis in original).

58. Bernard Barber, "Review of *Reflections on Big Science* by A. M. Weinberg."

Meier criticized Weinberg's proposal to scale up technological fixes in agro-nuclear complexes. Such "nuplexes," Meier argued, were a variant of earlier optimistic sociotechnical systems; the history of creating such large conglomerations of interdependent ancillary industries had shown them, he argued, to be "dismal failures," because they had not addressed "people problems" relating to "settlement procedures, laws, customs, education, marketing, management, and so on." Meier stated that technological fixes required carefully planned social interventions to be successful.⁵⁹

The most direct appraisal appeared nearly a decade after Weinberg's first speeches on the subject. Sociologists Eugene Burns and Kenneth Studer characterized his notions as simplistic:

It is not difficult to see the immediate sanity of such technological fixes as safer automobiles and polio vaccine, for these fixes complement many traditional social values. It is quite another thing, however, to believe that poverty is anywhere near as tractable as Weinberg suggests. His insensitivity to the *social* structure of social problems (e.g. with regard to poverty, relative deprivation, rising expectations, etc.) only too readily reveals the technico-scientific bias of his solutions. . . . Weinberg is thereby constrained to focus primarily on second-order social problems, namely problems that are precipitated by prior technological fixes.⁶⁰

In a subsequent exchange, the authors summarized Weinberg as proposing "scientistic, reductionistic, solutions"—an unsupportable faith in the methods of physical science and a myopic approach to problem-solving. Weinberg disingenuously denied "any grand social philosophy" or "mutual consistency" in his writings. "The authors read too much into my views when they claim to see this as evidence of my naïve belief in the possible redemption of society by science," he observed, but reiterated that "social fixes, no less than technological fixes, have deleterious and unforeseen side effects; and social fixes, precisely because they get to the heart of the matter rather than remedying effects, have a history of going more awry than do technological fixes."⁶¹

For wider audiences, critiques of technology, like expressions of technological faith, grew within a particular historical context. As Weinberg promoted his views during the late 1960s and early '70s, critical assessments from distinct sources identified reliance upon technological solutions as evidence for inadequate engineering practice, failures of government policy, or expressions of corporate self-interest. Health technologies raised few

59. Richard L. Meier, "The Social Impact of a Nuplex," 17.

60. Eugene M. Burns and Kenneth E. Studer, "Reflections on Alvin M. Weinberg," 34–35 (emphasis in original).

61. Alvin M. Weinberg, "Response to Burns and Studer's 'Reflections on Alvin M. Weinberg,'" 197, 199; Eugene M. Burns and Kenneth E. Studer, "Reply to Alvin M. Weinberg."

JULY

2018

VOL. 59

concerns during this period, which showed remarkable successes in developing treatments for illnesses and improving the quality of individual lives. Weinberg himself had cited cigarette filters as a technological fix that was self-evidently easier than persuading users to give up smoking.⁶² There were, however, specific topics that raised growing disquiet among consumers, notably concerns about the effects of food additives and dietary supplements and the depersonalization of scientific medicine.

Moreover, the growing counterculture of the 1960s portrayed the Vietnam War as a conflict in which the high technology developed by the U.S. military-industrial complex was proving impotent against a resourceful enemy employing more appropriate technologies.⁶³ For a wider cross-section of society alienated by a seemingly shrouded industry, nuclear energy raised growing concerns as inherently dangerous and potentially injurious to health.⁶⁴ And media accounts of the pollution of air and water increasingly pinned responsibility on short-sighted industries or more generically identified them as a widespread byproduct of industrial society.⁶⁵

As early as 1970, Weinberg attacked technological pessimism by appealing in his commencement addresses to college engineering graduates. For these audiences, Weinberg's defense was nuanced. He acknowledged that "technological fixes are viewed with great suspicion . . . by many social activists" and that "we technologists are aware of the shortcomings"; he noted that the green revolution in India had "created unemployment among agricultural workers as well as undermined the social structure of the village." But addressing politics more directly, he observed that social fixes had a history of errors at least as great: "our U.S. Constitution, with its intricate and almost mechanical checks and balances, represents a social fix on a grand scale. Or Karl Marx, with his curious mixture of Hegel and science created an all-encompassing system which was supposed to lead to Utopia on Earth." And, hinting at the ongoing impeachment proceedings against Nixon, Weinberg underlined that "our U.S. Constitution is imperfect; the incredible stresses it is now undergoing are evidence enough of this." In its place, he argued that technology could serve as a calming counter-force to

62. Alvin Weinberg to W. Hines, letter, 27 July 1967, "Chron 1967-2" file, cabinet 5, drawer 4, in CMOR.

63. Stuart W. Leslie, *The Cold War and American Science*; Peter Galison and Barton J. Bernstein, "Physics between War and Peace"; Paul Boyer, "From Activism to Apathy."

64. Fred H. Knelman, *Nuclear Energy*; Brian Balogh, *Chain Reaction*; Howard Hu, Katherine Yih, and Arjun Makhijani, *Nuclear Wastelands*.

65. For example, Love Canal, near Niagara Falls, New York, became infamous during the late 1970s as a human environment ruined by leakage from a toxic waste dump. From the late 1960s, technological opposition in the United States was directed successively toward the use of Agent Orange defoliant in Vietnam, the Supersonic Transport initiative, the Alaska Oil Pipeline, and, particularly after the Three Mile Island incident in 1977, nuclear power plants. See, for example, Peter H. Schuck, *Agent Orange on Trial*; Mel Horwitch, *Clipped Wings*; and Peter A. Coates, *The Trans-Alaska Pipeline Controversy*.

unstable politics: “Our political system is geared to a four-year cycle. This our founding fathers recognized as necessary to prevent against tyranny. But in guarding against tyranny we have created a mismatch: the time scale of politics is far shorter than the time span of technology.”

The “new style of social thinking,” he suggested, “forces us to look at our sociotechnological dilemmas from a longer perspective of time than is our custom.” Sound technological optimism, Weinberg concluded, tipped the balance from social to technological fixes: doomsayers quoting *Limits to Growth* would be countered by young technologists “who foresee solutions to all its problems.” This placed a unique responsibility on the technological elite to “use this sophistication to break prevailing chains of short-sightedness—even though at times it may place you in temporary disfavor. Your technological fixes will thereby become more humane; and, more importantly, each of your lives will thereby be made more richly human.”⁶⁶

But ethicists also weighed in. Max Oelschlaeger argued that the notion of the technological fix had become a popular myth accepted as much by large companies as the general population.⁶⁷ The ethical ramifications of technological reliance were more centrally addressed by philosopher Arne Naess from the early 1970s on. He argued that the seeming “reasonableness” of these solutions was largely determined by the narrow framing of the problem and failed to explore the cultural presuppositions about the nature and potency of technologies. Naess suggested a new framing in which technologically oriented, short-term “shallow” environmental solutions were replaced by “deep ecology,” seeking to address systemic faults holistically via a combination of social, cultural, and technical solutions.⁶⁸

The political dimensions of technological fixes, however, elicited perhaps the most enduring interest and illustrate the evolution of Weinberg’s views concerning technological power and expertise. As early as 1966, a reviewer for the Socialist Labor Party described Weinberg’s thesis as “speciously attractive” and agreed that the “social engineers [are] woefully ineffective,” but identified Marxism as the only genuine social science. Identifying technological change as “the force to which society’s institutions must ultimately conform,” it castigated Weinberg for having given up

66. Alvin M. Weinberg, “Technological Fixes and Social Fixes,” Commencement address, Stevens Institute of Technology, Hoboken, New Jersey, 3 June 1973, Box 114, folder 23, in MPA.0332; Club of Rome, *Limits to Growth*. Earlier examples broaching the topic include: Weinberg, “Technology, Youth, and the Environment,” Commencement address, Augsburg College, Minneapolis, 31 May 1970, Box 115, folder 9, in MPA.0332; Weinberg, “Towards a Compassionate Technology,” Commencement address, Worcester Polytechnic Institute, Worcester, Massachusetts, 6 July 1971, Box 116, folder 8, in MPA.0332.

67. Max Oelschlaeger, “The Myth of the Technological Fix.”

68. Arne Naess, “The Shallow and the Deep, Long-Range Ecology Movement”; Alan R. Drengson, *The Practice of Technology* and “The Sacred and the Limits of the Technological Fix.”

JULY
2018
VOL. 59

his conviction that society's agenda should focus on the major task of social reorganization.⁶⁹

Others argued that the technocratic faith implicit in Weinberg's work required an unlikely and worrying transfer of power to technologists—a criticism leveled at Meier's writings a decade earlier and indeed at the technocrats of the early 1930s.⁷⁰ In his lobbying for socially oriented big science, Weinberg had recognized that think tanks of experts were potentially dangerous, because technical complexities of the issues prevented public debate. "Many of our strategic doctrines . . . can be traced to RAND [and] it is somewhat disconcerting that they are formulated by experts who, at least from the outside, appear to sit apart and to operate on their own." His proposed solution was to establish two competing institutes, in the way that the Oak Ridge and Argonne and Los Alamos and Livermore national laboratories "keep each other honest." In this respect, Weinberg's views deviated from the earlier technocrats: where they had proposed replacing political leaders with governance by technologists, Weinberg envisaged engineers and scientists in government-funded national labs to devise solutions to problems identified by others. Both views, however, bypassed direct democratic involvement in favor of rational elites.⁷¹

During the 1980s and particularly via Shils and *Minerva*, Weinberg continued to contribute to developments in science and technology studies and reflected more explicitly on their political dimensions. He pronounced Langdon Winner's piece, "Building the Better Mousetrap," as "the most readable and cleverest of essays," and admitted learning more about the political ramifications of technology from Winner's "graceful essays" in *The Whale and the Reactor* (1986), while seemingly missing the most striking technological fix described in the book: his description of New York City parkway overpasses built low so that buses carrying urban poor were unable to reach prime suburban recreation areas. Equally surprisingly, there are no extant documents revealing his views about Winner's best-known essay, "Do Artifacts Have Politics?," which explores the link between technological innovation and political effects—a connection sought by Weinberg for two decades. Instead, he proffered that Winner was too pessimistic, underlining that "as a technologist unversed in politics, I would claim that technological fixes are easier than social fixes." Indeed, in his 1994 autobiography he asserted that his career was that of a "technological optimist" and "technological fixer."⁷²

69. "The Social Scientists."

70. Paul A. Baran, "Review of Meier, Richard L, *Science and Economic Development*," esp. 1021; William E. Akin, *Technocracy and the American Dream*; Beverley H. Burris, *Technocracy at Work*.

71. Weinberg, "Social Problems and National Socio-Technical Institutes," 433.

72. Alvin M. Weinberg, "How Appropriate Is Appropriate Technology?" and "A Wake-Up Call for Technological Somnambulists"; Langdon Winner, "Do Artifacts Have Politics?"

Conclusion: Trajectory of a Concept and a Career

There are ironies in Weinberg's promotion of the technological fix. Career experiences repeatedly challenged his lifelong faith in technological innovation as a societal resource. He was an early admirer of Rachel Carson and had actively promoted attention to the environmental side-effects of technologies. Weinberg was an early advocate of nuclear power as a low-carbon fix to avoid climate change, and regretted having done little at ORNL to focus attention on the persistent problem of nuclear waste disposal.⁷³ By the end of the 1960s, however, this progressive stance—distinctly out of step with many of his establishment peers—became blurred. His public addresses increasingly were targeted at “primarily the young, anti-technology revolutionaries and their more passive, but worried followers.”⁷⁴ And yet, his outspokenness was not on-message within the nuclear industry either. He was dismissed as the director of ORNL in 1973 during the first Nixon administration because of his publicly expressed criticisms of reactor safety.

Fashioning a role as director of the new Institute of Energy Analysis, Weinberg's proposed alternatives eroded his confident championing of technological fixes (fig. 4). He envisaged a combination of technical and social components to the solution: a new generation of “inherently safe” reactor designs, but strategically sited in large clusters far from populations, in high-security “nuclear parks” tended by a “nuclear priesthood” of specialists. Technological improvisation thus ceded place to ponderous societal rearrangements.⁷⁵ In a similar vein, he later suggested that the Hiroshima atomic bomb had been necessary and effective in the short term, but that only its public “elevation . . . to the status of a profoundly mystical event” could avoid future nuclear wars. Weinberg's neologism “trans-scientific” labeled such problems that transcended scientific analysis and required corollary social and moral considerations.⁷⁶

Over the same period, he reluctantly came to recognize that his lifelong optimism for nuclear power was unshared by the American public. In a letter to Shils, he concluded “the sorry history of nuclear power seems to support a growing view that risky technology is incompatible with liberal democracy,” and, reflecting on the relative success of nuclear programs in other countries, observed that “nuclear energy seems to do best where the

73. Weinberg, *The First Nuclear Era*, 117, 183, and “Technological Fixes, Carbon Dioxide and Water (Manuscript, 24 Mar 1994)” Box 114, folder 24, in MPA.0332; Patrick Moriarty and Damon Honnery, “Nuclear Energy.”

74. Emanuel Epstein to Alvin Weinberg, letter, 5 May 1971, unmarked file, cabinet 12, drawer 1, in CMOR.

75. Alvin M. Weinberg, “Social Institutions and Nuclear Energy,” “Salvaging the Nuclear Age,” and “Inherently Safe Technologies.”

76. Alvin M. Weinberg, “The Sanctification of Hiroshima” and “The Limits of Science and Trans-Science.”

JULY
2018
VOL. 59

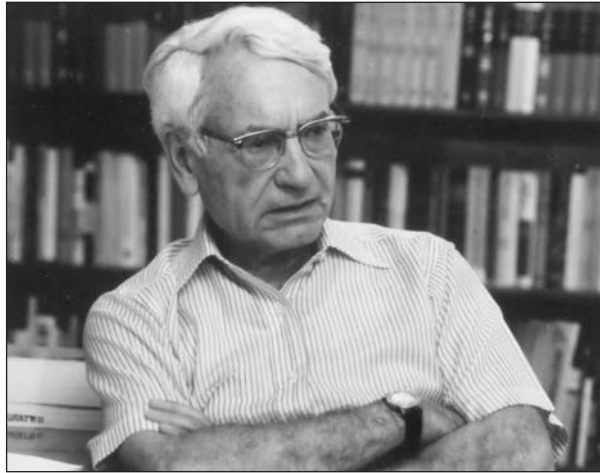


FIG. 4 Weinberg as first Director of the Institute of Energy Analysis, Oak Ridge Associated Universities, circa 1982. (Source: MPA.0332 Box 56, folder 16. University of Tennessee, Knoxville—Libraries.)

underlying political structure is elitist.” Alongside Winner, he acknowledged that certain technological solutions could not only produce powerful political consequences, but might also require particular political environments.⁷⁷

And yet, Weinberg’s curiously imprecise conception of technological fixes was remarkably successful, remaining in the public discourse from its origin in the mid-1960s over the following four decades of his life.⁷⁸ The present narrative has illustrated how his notion of the technological fix reflected the views of his peers and career context, and it can be traced to experiences shared by many U.S. technologists and analysts of his times. Why then did his particular ideas create such enduring impact?

First, Weinberg’s voice was favored as a national laboratory director with privileged access to policy-makers and industrialists. His active networking engaged peers from a broad range of disciplines as critical friends; his career translated him from an interwar progressive to an apolitical champion of progressive technologies. Instead of opposing politicians as the technocrats had, he conceived nationally funded technologists, and their technological fixes, as the tools of good government.

77. Alvin Weinberg to Edward Shils, letter, 30 August 1988, box 78, folder 9, in MPA; Alvin M. Weinberg, “Nuclear Power and Public Perception,” 279.

78. Anthologies include Mesthene, ed., *Technology and Social Change*; Noel de Nevers, ed., *Technology and Society*; Albert H. Teich, ed., *Technology and Man’s Future*; Nigel Cross, David Elliott, and Robin Roy, eds., *Man-Made Futures*; Albert Teich, ed., *Technology and the Future*; W. B. Thompson, ed., *Controlling Technology*; Alvin M. Weinberg, ed., *Nuclear Reactions*; M. Anne Howard, ed., *An Environmental Policy Reader*; Nancy R. MacKenzie, ed., *Science and Technology Today*; and Gail E. Hawisher and Cynthia L. Selfe, eds., *Literacy, Technology, and Society*.

Second, Weinberg was a skilled and tireless communicator. He crafted his writings to be readily absorbed and was unusually active in promoting the republication of his essays for varied audiences. Meier suggested that his coinage itself was seductive: the word *fix* connoted “a dramatic improvement, and therefore, it was widely discussed.” Other scholars, while critical of Weinberg’s views, praised his role as “one of the more outstanding and articulate of the science policy thinkers,” whose clearly formulated views allowed “a more incisive criticism.”⁷⁹ On the other hand, his shifting public stances effectively reflected his evolving confidences and varied audiences. Weinberg was at his most bullish and optimistic in commencement addresses to college engineering graduates, but tentative and conciliatory in communications directed at scholars of social sciences and humanities. His musings framed questions to encourage discussion.

Third, and most importantly for his long-lived influence, Weinberg’s rhetorical style eluded detailed unpacking. A “Teflon man” before the term was coined for Ronald Reagan, he achieved fame with little notoriety by deftly shedding criticism; his examples were brief and appealed to common sense rather than thorough analysis. Definitions of technological fixes were mutable, alternately conceived as temporary solutions that bought time for social methods or as large-scale systems that shaped citizen options and replaced social science altogether. He also skillfully preempted criticism by raising some of his critics’ objections himself. Playing devil’s advocate and portraying himself as neutral and diffident rather than polemical, his ambivalence preserved his critical stance.⁸⁰

In later years, Weinberg identified himself more overtly and confidently with technological fixes. What he had painted as disingenuous “what-if” scenarios in the late 1960s were openly represented as matters of personal conviction and even defiance a quarter-century later. In his final decade, Weinberg reflected that “Paul Ehrlich’s derisive description” of him as “king of the technological optimists” was justified, but that he nevertheless felt vindicated: “I write as the Cold War has ended. Deep in our hearts we realize that all this was made possible by a technological fix—the hydrogen bomb.”⁸¹

While critiqued by particular audiences, Weinberg’s seductive notions were mainstreamed to shape the confidences of those seeking solutions to novel and enduring societal problems. Notions that had at mid-century been the province of a technological elite became a widely shared belief of broader publics. As an articulate voice for technological solutions to wider societal issues, he consolidated and lucidly framed ideas circulating among his peers. By offering examples and discussing their wider implications—and just as

79. Meier, “The Social Impact of a Nuplex,” 16; Burns and Studer, “Reflections on Alvin M. Weinberg.”

80. Alvin M. Weinberg, “Beyond the Technological Fix,” 3.

81. Alvin M. Weinberg, “Chapters from the Life of a Technological Fixer.”

importantly, by labeling the concept concisely—Weinberg's rhetoric shaped and continues to influence discourses about technological solutions to societal problems, and about the wider roles of technology in society.

Bibliography

JULY

Archival Sources

2018

Weinberg Archives, Children's Museum of Oak Ridge (CMOR)

VOL. 59

Weinberg Papers, Modern Political Archives (MPA), Howard H. Baker Jr. Center for Public Policy, University of Tennessee, Knoxville

Interview Source

Alex Zucker, personal interview with the author, 16 May 2016, Oak Ridge

Published Sources

Akin, William E. *Technocracy and the American Dream: The Technocracy Movement, 1900–1941*. Berkeley: University of California Press, 1977.

Balogh, Brian. *Chain Reaction: Expert Debate and Public Participation in American Commercial Nuclear Power, 1945–1975*. New York: Cambridge University Press, 1991.

Baran, Paul A. "Review of Meier, Richard L, *Science and Economic Development: New Patterns of Living*." *American Economic Review* 47, no. 6 (1956): 1019–21.

Barber, Bernard. "Review of *Reflections on Big Science* by A. M. Weinberg." *American Journal of Sociology* 76, no. 1 (1970): 169–71.

Bethe, Hans. "The Social Responsibilities of Scientists and Engineers." *Cornell Engineer* 29 (1963): 6.

Boyer, Paul. "From Activism to Apathy: The American People and Nuclear Weapons, 1963–1980." *Journal of American History* 70, no. 4 (1984): 821–44.

Branscomb, Lewis M. "Harvey Brooks." *Proceedings of the American Philosophical Society* 154, no. 4 (2004): 461–69.

Brooks, Harvey. "The Evolution of U.S. Science Policy." In *Technology, R&D, and the Economy*, edited by L. R. Bruce and C. E. Barfield, 14–49. Washington, DC: Brookings Institution, 1996.

Burns, Eugene M., and Kenneth E. Studer. "Reflections on Alvin M. Weinberg: A Case Study on the Social Foundations of Science Policy." *Research Policy* 4, no. 1 (1975): 28–44.

———. "Reply to Alvin M. Weinberg." *Research Policy* 5, no. 2 (1976): 201–2.

Burris, Beverley H. *Technocracy at Work*. Albany: State University of New York Press, 1993.

Bylinsky, Gene. "Is 'Big Science' Headed for 'Big Trouble?'" *Huntsville Times*, 15 March 1963, 2.

Carson, Rachel. *Silent Spring*. New York: Houghton Mifflin, 1962.

- Club of Rome. *Limits to Growth*. New York: Signet, 1972.
- Coates, Peter A. *The Trans-Alaska Pipeline Controversy: Technology, Conservation, and the Frontier*. Cranbury, NJ: Associated University Presses, 1991.
- Cohen, Jerry, and William S. Murphy. *Burn Baby Burn! The Los Angeles Race Riots of August 1965*. London: Avon, 1966.
- Cross, Nigel, David Elliott, and Robin Roy, eds. *Man-Made Futures: Readings in Society, Technology and Design*. London: Nelson Thornes, 1974.
- "Cure Cancer? Go to Mars? Is Big Science Ruining U.S. Financially?" *Oak Ridger*, 9 May 1961, 1.
- Drengson, Alan R. "The Sacred and the Limits of the Technological Fix." *Zygon* 19, no. 3 (1984): 259–75.
- . *The Practice of Technology: Exploring Technology, Ecophilosophy, and Spiritual Disciplines for Vital Links*. Albany: State University of New York Press, 1995.
- Eisenhower, Dwight D., and Lewis J. Strauss. "A Proposal for Our Time." *Reader's Digest*, June 1968, 75–79.
- Ellul, Jacques. *La Technique, Ou L'enjeu du Siècle*. Paris: Armand Colin, 1954.
- Galison, Peter, and Barton J. Bernstein. "Physics between War and Peace." In *Science, Technology, and the Military*, edited by Everett Mendelsohn, Merritt Roe Smith, and Peter Weingart, 47–86. Dordrecht: Kluwer Academic, 1988.
- Hardin, Garrett. "Lifeboat Ethics: The Case against Helping the Poor." *Psychology Today* 8 (September 1974): 38–43.
- Hawisher, Gail E., and Cynthia L. Selfe, eds. *Literacy, Technology, and Society: Confronting the Issues*. Urbana-Champaign: University of Illinois Press, 1997.
- Hewlett, Richard G., and Francis Duncan. *Nuclear Navy, 1946–1962*. Chicago: University of Chicago Press, 1974.
- Horwitch, Mel. *Clipped Wings: The American SST Conflict*. Cambridge, MA: MIT Press, 1982.
- Howard, M. Anne, ed. *An Environmental Policy Reader*. Buffalo, NY: Harcourt Brace, 1994.
- Hu, Howard, Katherine Yih, and Arjun Makhijani. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Cambridge, MA: MIT Press, 1995.
- Hubbert, M. King. "Lesson 22: Industrial Design and Operating Characteristics." In *Technocracy Study Course*, 242–68. New York: Technocracy Inc., 1945.
- Hughes, Thomas P. *American Genesis: A Century of Invention and Technological Enthusiasm, 1870–1970*. Chicago: University of Chicago Press, 1989.
- . "Afterword." In *The Technological Fix: How People Use Technology*

JULY
2018
VOL. 59

- to Create and Solve Problems*, edited by Lisa Rosner, 219–40. New York: Routledge, 2004.
- Huntington, Ellsworth. *Civilization and Climate*. New Haven, CT: Yale University Press, 1915.
- Johnston, Sean F. *The Neutron's Children: Nuclear Engineers and the Shaping of Identity*. Oxford: Oxford University Press, 2012.
- . “Technological Parables and Iconic Illustrations: American Technocracy and the Rhetoric of the Technological Fix.” *History and Technology* 33, no. 2 (2017): 196–219.
- Kimbrell, Edward. “Weinberg-Baker Propose Socio-Techno Institutes.” *Chicago Daily News*, 12 August 1967, 8.
- Knelman, Fred H. *Nuclear Energy: The Unforgiving Technology*. Edmonston, AB: Hurtig, 1976.
- Leslie, Stuart W. *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford*. New York: Columbia University Press, 1993.
- MacKenzie, Nancy R., ed. *Science and Technology Today*. New York: St. Martin's Press, 1995.
- Marcuse, Herbert. *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society*. London: Routledge, 1964.
- Meier, Richard L. *Science and Economic Development: New Patterns of Living*. New York: Wiley, 1956.
- . *Modern Science and the Human Fertility Problem*. New York: Wiley, 1959.
- . “The Social Impact of a Nuplex.” *Bulletin of the Atomic Scientists* 25, no. 3 (1969): 16–21.
- . *Planning for an Urban World: The Design of Resource-Conserving Cities*. Cambridge, MA: MIT Press, 1974.
- Mesthene, Emmanuel G. “On Understanding Change: The Harvard University Program on Technology and Society.” *Technology and Culture* 6, no. 2 (1965): 222–35.
- , ed. *Technology and Social Change*. Indianapolis: Bobbs-Merrill, 1967.
- . “How Technology Will Shape the Future.” *Science* 161 (12 July 1968): 135–43.
- Michel, Jean-Baptiste, Yuan Kui Shen, Aviva Presser Aiden, Adrian Veres, Matthew K. Gray, Google Books Team, Joseph P. Pickett, et al. “Quantitative Analysis of Culture Using Millions of Digitized Books.” *Science* 331, no. 6014 (2011): 176–82.
- Moriarty, Patrick, and Damon Honnery, eds. “Nuclear Energy: The Ultimate Technological Fix?” In *Rise and Fall of the Carbon Civilisation: Resolving Global Environmental and Resource Problems*, 103–24. London: Springer-Verlag, 2011.

- Morozov, Evgeny. *To Save Everything, Click Here: Technology, Solutionism, and the Urge to Fix Problems That Don't Exist*. London: Penguin, 2014.
- Mumford, Lewis. *Technics and Civilization*. New York: Harcourt, 1934.
- Nader, Ralph. *Unsafe at Any Speed*. New York: Grossman, 1965.
- Naess, Arne. "The Shallow and the Deep, Long-Range Ecology Movement: A Summary." *Inquiry* 16 (1973): 95–100.
- "NCHA Plans Public Housing Air-Conditioning." *Washington Post*, 5 January 1968, 22.
- Neumann, John von. "Can We Survive Technology?" *Fortune* 51 (1955): 106.
- Nevers, Noel de, ed. *Technology and Society*. New York: Addison-Wesley, 1972.
- Newman, M. W. "Calls Dread of the Atom Bar to War: Fear Has Kept a Miserable Kind of Peace, Says Scientist." *Chicago Daily News*, 14 June 1960, 18.
- Oelschlaeger, Max. "The Myth of the Technological Fix." *Southwestern Journal of Philosophy* 10, no. 1 (1979): 43–53.
- Royal Society. *Geoengineering the Climate: Science, Governance and Uncertainty*. London: Royal Society, 2009.
- Schuck, Peter H. *Agent Orange on Trial: Mass Toxic Disasters in the Courts*. Cambridge, MA: Harvard University Press, 1986.
- Scott, Howard. "Public Lecture by Howard Scott." 1 September 1937, Winnipeg, MB. In *The Words and Wisdom of Howard Scott, 1890–1970*, vol. 1, 156–58. Akron, OH: Section 3, Regional Division 8141, Technocracy Inc., 1989.
- _____. "Design, Direction or Disaster." Talk by Howard Scott. 15 March 1958, Detroit, 1958. <https://www.youtube.com/watch?v=tTjzyUO5rq8> (accessed 29 February 2016).
- Seaborg, Glenn. "Toward a Science of 'Techumology.'" *Air Force and Space Digest* 50, no. 12 (1967): 82–84.
- "The Social Scientists." *Weekly People*, 12 November 1966, 1.
- Solla Price, Derek, de. "The Acceleration of Science—Crisis in Our Technological Civilization." *Product Engineering* 32 (1961): 56–59.
- _____. "The Beginning and the End of the Scientific Revolution, 1670–1970." *Lehigh Alumni Bulletin* 48 (1961): 6–9.
- _____. *Little Science, Big Science*. New York: Columbia University Press, 1963.
- Stow, Stephen H. "An Interview with Alvin Weinberg." Oak Ridge Oral History Project, 2003. Available at <http://cdm16107.contentdm.oclc.org/cdm/ref/collection/p15388coll1/id/165> (accessed 11 March 2016).
- Teich, Albert H., ed. *Technology and Man's Future*. New York: St. Martin's Press, 1972.

JULY
2018
VOL. 59

- _____. *Technology and the Future*. New York: St. Martin's Press, 1997.
- Thompson, W. B., ed. *Controlling Technology: Contemporary Issues*. Buffalo, NY: Prometheus, 1991.
- Trademarkia. "There's an App for That Trademark Information," n.d. Available at <http://www.trademarkia.com/theres-an-app-for-that-77980556.html> (accessed 10 September 2016).
- _____. "The University and Society." *New York Times*, 10 August 1965, 32.
- Weinberg, Alvin M. "Big Science—Marvel or Menace?" *New York Times Magazine*, 23 July 1961, 15, 41, 51.
- _____. "'Big Science': A Liability? Excerpts of Talk before the American Rocket Society—ORNL Space—Nuclear Conference." *Christian Science Monitor*, 7 February 1962, 2.
- _____. "Impact of Large Scale Science in the U.S." *Scientific World* 6 (1962): 8–12.
- _____. "Basic Research and National Goals: A Report to the Committee on Science and Astronautics, U.S. House of Representatives, by the National Academy of Sciences." *Minerva* 3, no. 4 (1965): 499–523.
- _____. "Can Technology Replace Social Engineering?" *Oak Ridge National Laboratory News*, June 1966, 1–4.
- _____. "Can Technology Replace Social Engineering?" *Scientific Research* 1 (July 1966): 152–56.
- _____. "Is Technology the Answer to All Our Problems?" *Los Angeles Times*, 9 October 1966, G3.
- _____. "Can Technology Replace Social Engineering?" *University of Chicago Magazine* 59 (October 1966): 6–10.
- _____. "Can Technology Replace Social Engineering?" *Bulletin of the Atomic Scientists* 22 (December 1966): 4–7.
- _____. "Can Technology Replace Social Engineering?" *Air Force and Space Digest* 50 (January 1967): 55–58.
- _____. "Can Technology Replace Social Engineering?" *American Behavioral Scientist* 10, no. 9 (May 1967): 7–10.
- _____. "Can Technology Replace Social Engineering?" *Chicago Jewish Forum* 25, no. 4 (summer 1967): 131–37.
- _____. "Can Technology Stabilize the World Order?" *Public Administration Review* 27 (1967): 460–82.
- _____. *Reflections on Big Science*. Cambridge, MA: MIT Press, 1967.
- _____. "Social Problems and National Socio-Technical Institutes." In *Applied Science and Technological Progress: A Report to the Committee on Science and Astronautics*. U.S. House of Representatives by the National Academy of Sciences, 415–34. Washington, DC: NAS, 1967.
- _____. "Social Institutions and Nuclear Energy." *Science* 177 (1972): 27–34.
- _____. "Response to Burns and Studer's 'Reflections on Alvin M. Weinberg.'" *Research Policy* 5 (1976): 197–200.

- _____. "The Limits of Science and Trans-Science." *Interdisciplinary Science Reviews* 2, no. 4 (1977): 337–42.
- _____. "Beyond the Technological Fix." Institute for Energy Analysis, Oak Ridge Associated Universities. ORAU/IEA 78-5(0), 1978. <https://www.osti.gov/servlets/purl/7036775> (accessed 9 September 2016).
- _____. "Salvaging the Nuclear Age." *Wilson Quarterly*, summer 1979, 88–112.
- _____. "How Appropriate Is Appropriate Technology?" *Minerva* 18, no. 3 (1980): 529–31.
- _____. "Inherently Safe Technologies (Chemical and Nuclear)." *Institute for Energy Analysis Newsletter* 6 (1984): 3–8.
- _____. "The Sanctification of Hiroshima." *Bulletin of the Atomic Scientists* 41 (1985): 34.
- _____. "A Department of Science, 1985 Edition." *Technology in Society* 8 (1986): 145–47.
- _____. "A Wake-Up Call for Technological Somnambulists" (review of Langdon Winner's *The Whale and the Reactor*). *The Scientist* 1 (January 1987). <https://www.the-scientist.com/books-etc/-a-wake-up-call-for-technological-somnambulists-64117>.
- _____, ed. "Nuclear Power and Public Perception." In *Nuclear Reactions: Science and Trans-Science*. New York: American Institute of Physics, 1992.
- _____. "Chapters from the Life of a Technological Fixer." *Minerva* 31, no. 4 (1993): 379–454.
- _____. *The First Nuclear Era: The Life and Times of a Technological Fixer*. Woodbury, NY: AIP Press, 1994.
- _____. "Edward Shils and the 'Governmentalization' of Science." *Minerva* 34, no. 1 (1996): 39–43.
- "Weinberg Touts 'Technological Fixes' to Stabilize World." *Oak Ridger*, 12 October 1966, 1.
- Wigner, Eugene, and Andrew Szanton. *The Recollections of Eugene P. Wigner*. New York: Plenum, 1992.
- Winner, Langdon. "Do Artifacts Have Politics?" *Daedalus* 109, no. 1 (1980): 121–36.
- Wood, Charles H. "The Birth of the Technical Alliance." *New York World*, 20 February 1921. Reprinted in Technocracy Inc., *The Words and Wisdom of Howard Scott 1890–1970*, vol. 1, 13–18. Akron, OH: Technocracy Inc., 1989.