The Technological Fix as Social Cure-All

Origins and Implications

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FIGURE 1. Engineers and scientists as social problem-solvers [source: *New York Herald Tribune*, 7 Aug 1945 (the day after Hiroshima), p.22].

In 1966, a well-connected engineer posed a provocative question: will technology solve all our social problems? He seemed to imply that it would, and soon. Even more contentiously, he hinted that engineers could eventually supplant social scientists — and perhaps even policy-makers, lawmakers, and religious leaders — as the best trouble-shooters and problem-solvers for society (1).[1]

The engineer was the Director of Tennessee's Oak Ridge National Laboratory, Dr. Alvin Weinberg. As an active networker, essayist, and contributor to government committees on science

[1]Weinberg's second speech on the topic was more cautiously titled, and was reprinted in numerous journals and magazines and widely anthologized in university texts (2).

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and technology, he reached wide audiences over the following four decades.

Weinberg did not invent the idea of technology as a cure-all, but he gave it a memorable name: the "technological fix." This article unwraps his package, identifies the origins of its claims and assumptions, and explores the implications for present-day technologists and society. I will argue that, despite its radical tone, Weinberg's message echoed and clarified the views of predecessors and contemporaries, and the expectations of growing audiences. His proselytizing embedded the idea in modern culture as an enduring and seldom-questioned article of faith: technological innovation could confidently resolve any social issue.

Weinberg's rhetorical question was a call-to-arms for engineers, technologists, and designers, particularly those who saw themselves as having a responsibility to improve society and human welfare. It was also aimed at institutions, offering goals and methods for government think-tanks and motivating corporate mission-statements (e.g., [3]).

The notion of the technological fix also proved to be a good fit to consumer culture. Our attraction to technological solutions to improve daily life is a key feature of contemporary lifestyles. This allure carries with it a constellation of other beliefs and values, such as confidence in reliable innovation and progress, trust in the impact and effectiveness of new technologies, and reliance on technical experts as general problem-solvers.

This faith can nevertheless be myopic. It may, for example, discourage adequate assessment of side-effects — both technical and social — and close examination of political and ethical implications of engineering solutions. Societal confidence in technological problem-solving consequently deserves critical and balanced attention.

Faith in Fixes

Adoption of technological approaches to solve social, political and cultural problems has been a longstanding human strategy, but is a particular feature of modern culture. The context of rapid innovation has generated widespread appreciation of the potential of technologies to improve modern life and society. The resonances in modern culture can be discerned in the ways that popular media depicted the future, and in how contemporary problems have increasingly been framed and addressed in narrow technological terms.

While the notion of the technological fix is straightforward to explain, tracing its circulation in culture is more difficult. One way to track the currency of a concept is via phrase-usage statistics. The invention and popularity of new terms can reveal new topics and discourse. The Google N-Gram Viewer is a useful tool that analyzes a large range of published texts to determine frequency of usage over time for several languages and dialects [4], [5].

In American English, the phrase *technological fix* emerges during the 1960s and proves more enduring and popular than the less precise term *technical fix* (Figure 2).

We can track this across languages. In German, the term *technological fix* has had limited usage as an untranslated English import, and is much less common than the generic phrase *technische Lösung* ("technical solution"), which gained ground from the 1840s. In French, too, there is no direct equivalent, but the phrase *solution technique* broadly parallels German and English usage over a similar time period. And in British English, the terms *technological fix* and *technical fix* appear at about the same time as American usage, but grow more slowly in popularity. Usage thus hints that there are distinct cultural contexts and meanings for these seemingly similar terms. Its varying currency suggests that the term *technological fix* became a cultural export popularized by Alvin Weinberg's writings on the topic, but related to earlier discourse about technology-inspired solutions to human problems.

Such data suggest rising precision in writing about technology as a generic solution-provider, particularly after the Second World War. But while the modern popularization and consolidation of the more specific notion of the "technological fix" can be traced substantially to the writings of Alvin Weinberg, the idea was promoted earlier in more radical form.

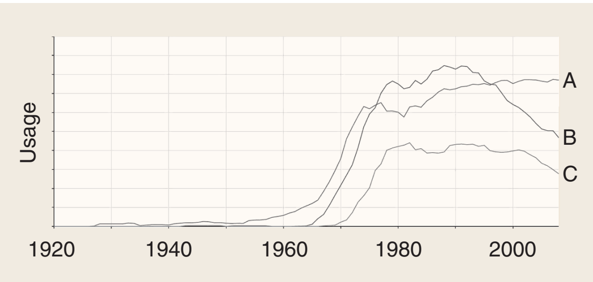

FIGURE 2. Modern problem-solving rhetoric: Usage of the terms: A — "technological solution," B — "technological fix," and C — "technical fix," according to Google n-gram analysis.

The Voices of Technocracy

Journalists after the First World War christened modern culture "the Machine Age," a period that vaunted the mechanization of cities and agriculture, industrial efficiency, "scientific management," and most of all, engineering solutions to modern problems [6], [7]. Social progress became associated with applied

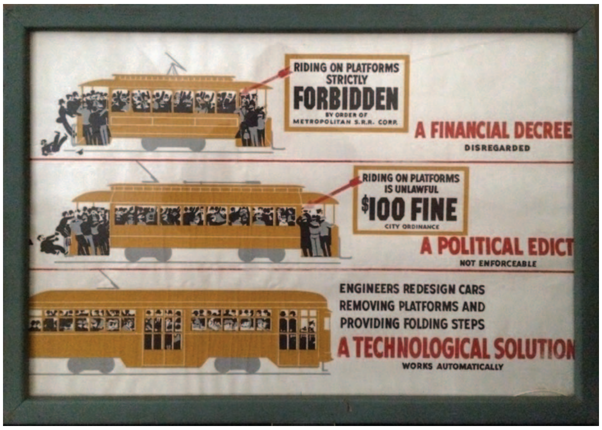

FIGURE 3. Graphic displayed at Technocracy Inc meeting halls and public exhibits from the 1930s [source: Technocracy Inc, courtesy of George Wright].

science. Electric appliances, for example, extended productivity and leisure pursuits; radio entertained, educated, and united the nation; motor vehicles and aircraft provided a new mobility for at least a privileged few.

But praise of technological change was accompanied by criticisms of the imperfections of modern society, often by the same analysts. The longest-lived voices were members of a group initially called the Technical Alliance, and later Technocracy Inc. Although having no verifiable engineering training, Howard Scott became the Chief Engineer and persuasive spokesperson for the Alliance, which included General Electric engineer Charles Steinmetz, social philosopher Thorstein Veblen, and economist Stuart Chase. The group railed against the problems of waste, inefficiency, and incompetence of industrialists and government leaders, and called for the application of "the achievements of science to societal and industrial affairs" ([8], see also [9]). They sought to collect reliable facts and to apply rational engineering principles to modern problems of all kinds.

The group is noteworthy in the way it boiled down popular ideas circulating among engineers for wider publics. Scott first reached audiences through a newspaper interview. He described how streetcar design had been improved to safeguard passengers, who often suffered injuries by falling from crowded running boards. Instead of relying on ineffective laws, policing, and public education, Scott said, "The engineers solved it easily. They built cars that didn't have platforms" [10].

FIGURE 4. Richard L. Meier c1965 [source: University of California, courtesy of Meier family].

The tale communicated Scott's common-sense conviction that social measures could be rendered unnecessary by wise engineering. Streetcars with retracting steps and closing doors ensured that passengers could not harm themselves. The anecdote was so effective in describing the essence of technological fixes that it became a feature of Scott's speeches for the successor organization, Technocracy Inc. and was reproduced as a graphic (Figure 3) on postcards and placards over the following eight decades [11]. His second-in-command, oil geologist Marion King Hubbert, featured similar examples in their *Technocracy Study Course*, which the organization updated into the twenty-first century [12].

Postwar Recovery and Optimism

Though the technocrats were most prominent during the 1930s, they also found fresh audiences after the Second World War. Rallies and long-distance road cavalcades across North America carried their message about the power of technologies to transform society. Engineers and scientists comprised a significant fraction of their membership and audiences, including those who had worked on the Manhattan Project during the war and were now imagining applications of nuclear energy. Their inspiration was to apply rapid innovation to recalcitrant human problems that had outlasted the war (Figure 1).

Among them was Richard L. Meier (1920–2007, Figure 4), a wartime research chemist who turned to investigating technological solutions for postwar urban problems. He was a technological optimist who conceived socio-technological systems to reduce inequity and yield wider societal benefits.

At least one contemporary reviewer identified "naïve rationalism" and "the spirit of technocratic speculation" in Meier's enthusiasms [13]. His work over subsequent decades was, however, the antithesis of the technocrats' casual claims as it carefully explored the political, economic, social, and cultural dimensions of complex technological systems affecting urban and regional development (see for example, [14]–[16]).

Other contemporary scientists supported similar views, some of whom — like Meier and Weinberg — joined the Federation of Atomic Scientists, a new organization seeking to guide beneficial applications of nuclear energy [17]. A sounding board for Weinberg's ideas was Harvey Brooks, Dean of

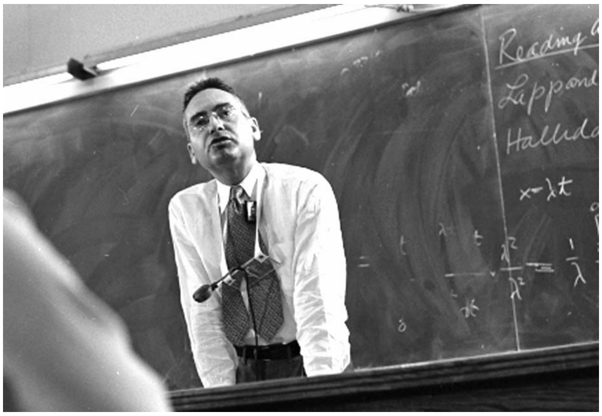

FIGURE 5. Alvin Weinberg teaching at the Oak Ridge Institute for Nuclear Studies, 1946. Courtesy of Oak Ridge National Laboratory (ORNL).

Engineering and Applied Physics at Harvard. Brooks, too, had participated in nuclear reactor design and had an interest in applying scientific expertise for societal benefit (18). In an era of growing technological confidence, these hopeful analysts and their peers offered a rational route for societal improvement.

Weinberg's Formulation: National Labs for Societal Problems

Alvin Weinberg's optimism identified rational analysis and technological innovation as the key drivers of societal progress. He argued that it was "the brilliant advances in the technology of energy, of mass production, and of automation," not social systems or ideologies, that "created the affluent society" (19).

> **Weinberg promoted the belief that technological innovation could resolve any social issue as an article of faith.**

Weinberg (1915–2006, Figures 5 and 6) focused his postwar career on the design, applications, and wider implications of nuclear reactors, becoming Director of the Oak Ridge National Laboratory (ORNL) in 1955. His high-profile position allowed Weinberg to represent not just the nascent field of nuclear engineering, but also the closer integration of technological innovation with the goals of modern American society (20). His networking provided him with experience as a senior administrator in the new environment of publicly funded engineering in the national interest, and insights about the new scale and societal implications of "big science," a term he popularized (21).

As Weinberg later recalled,

> I began to look upon nuclear energy as a symbol of a new technologically oriented civilization — the ultimate "technological fix" that would forever eliminate quarrels over scarce raw materials. I coined the phrase "technological fix" to connote technical inventions that could help resolve predominantly social problems….

So closely was he identified with the concept that Weinberg later characterized his career as that of a "technological fixer" (22). (On the gestation of his ideas see (23)).

Weinberg's cogent articles did not present the polemics of an interwar technocrat. He was cautious not to reveal his own political views, and avoided blaming politicians and economists for societal imperfections. Instead, Weinberg packaged the concept of the technological fix in a form that invited responses from policy-makers.

Weinberg's examples of technological fixes ranged from common-sense solutions to provocative examples that seemed to lie on an ethically slippery slope. His easy-to-accept cases included consumer campaigner Ralph Nader's contention that engineering safer cars might provide quicker reduction of traffic deaths than trying to change driving behaviors. Similarly, he argued that cigarette filters were obviously better than legislation or health education campaigns to convince smokers to give up cigarettes. But Weinberg also offered more uncomfortable illustrations, for example the notion of providing free air conditioners to literally cool down urban tensions in American cities of the late 1960s, or the benefits of intrauterine devices (IUDs) to limit family size and economic deprivation (24).

As a member of government policy panels during the Eisenhower, Kennedy, and Johnson administrations, Weinberg gained the ears of legislators. Besides the air-conditioning of slums, he lobbied for a wall between North and South Vietnam to limit enemy incursions and thus scale down the war, although he quickly labeled it an "amateurish notion" after feedback from his peers (25), (26).[2] Weinberg disclaimed other ideas — notably the general provision of *soma* pills to relieve unhappiness, as portrayed in Aldous Huxley's *Brave New World*, to suggest there were limits to how far technological fixes should go. He adapted to

[2]As Weinberg realized, his Vietnam wall — like Hadrian's Wall across northern Britain, the Great Wall of China, the Berlin Wall, and Donald Trump's proposed Mexican wall — is a technological fix for controlling population movements.

his audiences, being circumspect about the feasibility of technological fixes when writing for experts in the social sciences but optimistic when preaching to classes of engineering graduates.

For legislators and the 1968 Presidential candidates, Weinberg proposed a national strategy founded on technological fixes. He argued that the expertise in physical science and engineering marshalled at National Labs since the war could be reoriented to solve predominantly social problems. The "neat trick," he confided to Harvey Brooks, was that "social problems could be converted into technological problems" (27), (28). With national oversight, he suggested, technological analysis and problem-solving could trump traditional social, political, economic, educational, and moral approaches.

FIGURE 6. Alvin Weinberg in Washington, late 1960s. Courtesy of ORNL and the Howard H. Baker Jr Center for Public Policy, University of Tennessee.

Influenced by campaigners such as Scott, Meier, and Weinberg, popular support for technological solutions was particularly strong in the decades after the war.

For Weinberg the Manhattan Project represented the paradigm technological fix, in which a powerful technology neutralized enemy aggression and bypassed diplomatic negotiation and political alliances. Similarly, he credited the H-bomb as a technological solution to the problem of war that did not require changing human nature.

For Meier and Weinberg, postwar planning had provided evidence that rationalized housing, transport and communication networks could quickly improve the quality of life in cities under any political system. Nascent nuclear energy projects also channeled the promise of new technology to transform societies. During the Atoms for Peace initiative of the mid-1950s, for example, atomic energy was forecast as a means of irradiating food to avoid spoilage, desalinating seawater to irrigate deserts, and increase food production, and supplying low-cost electrical power to boost economies (29).

Over the following decade, the successes of major technological projects provided confidence in engineering ingenuity to achieve ambitious goals. The space race addressed seemingly insoluble technical challenges and, as trumpeted by NASA, its contractors and media sources, spun off associated technologies for consumer benefit.[3] Urban planners supported regeneration projects in which reconfigured infrastructure would transform social life, such as implementing expressway networks in lock-step with urban renewal. Supporting these enthusiastic forecasts was a widespread but seldom interrogated popular faith in the link between technological and social progress, as well as underlying belief in technological determinism and the inevitability of social adaptation to innovation.

Even more widely accepted examples of technological fixes were to be found in technologies applied to health and wellbeing. In a period of unprecedented access to inexpensive food, scientific nutrition was popularized by via over-the-counter vitamin supplements and diet aids.[4] Such fixes, argued supporters, could correct for unbalanced dietary regimes, hectic lifestyles, inexpert cooking, lack of will power, or low income.[5] Perhaps the most dramatic of technological fixes for lifestyle and diet-induced illness was the heart transplant, first trialed to public acclaim during the late 1960s, and hopes for artificial hearts (34).[6]

More recently, software technologies have been embraced by consumers as even more seductive ways to supplement personal skills, improve efficiency, and empower lifestyles — a marketing philosophy dubbed "solutionism." By sidestepping traditional forms of education, self-motivation, skills development, or political action, such software solutions are technological fixes in precisely the form defined by Weinberg.[7]

Institutional Confidence in Fixes

Technological fixes also remain popular for organizations and government as solutions to novel and acute problems today. A couple of broad issues can suggest prevalent attitudes.

A first domain is resolution of environmental problems. As environmental concerns rose in the late 1960s, with growing attention to air and river pollution, oil-tanker spills, and fears about nuclear waste,

[3]For a nuanced account of the socio-political context of spaceflight, see (30)).

[4]On the enrichment of staple foods with vitamins, see (31). A more recent example is "golden rice" bioengineered to produce beta-carotene as a technological fix for malnutrition from vitamin deficiency.

[5]The socio-technical system of preserving, transporting, and consuming frozen foods, for example, was largely a post-Second World War development involving new technologies (notably refrigeration and microwave-cooking) co-evolving with social and cultural changes (e.g., declining proportion of primary homemakers and rise of convenience foods) (32). Dietary aids included a rapidly expanding variety of over-the-counter products to increase metabolism, reduce appetite or fat absorption, and exercise machines to burn calories (33).

[6]Other technological fixes for health include gastric bands and liposuction.

[7]E.g., "technology-enhanced learning" and "technology-mediated communication" are growing industries, and the Apple slogan "There's an App for that" offers software solutions for human needs.

> **Framing by elites may disempower communities that opt for technological fixes.**

technological quick fixes were proposed as timely and reassuring solutions. Current options include oil-digesting microbes to deal with spills and industrial waste, biodegradable packaging, biotechnologies for fuel production, and schemes for addressing anthropogenic climate change via geo-engineering [35]–[37].

A second domain of problems attracting technology-dominated responses is terrorism. As airplane hijackings proliferated during the early 1970s, and more varied threats were identified after 2000, technologists responded with imaginative solutions ranging from low-tech lockable cockpit doors, to technologies monitoring Internet communications, to materials-detecting and body-scanning systems. In the tradition of technological fixes, these hardware solutions are rapid responses to events that have relatively complex social, political, or economic roots.[8]

Quandaries and Implications of Technological Fixes

Such examples suggest support for the notion of technological fixes by large companies, governments and the general population, as much as by engineers themselves [39]. But alongside unreflective acceptance of clever technological solutions for urgent problems, there is evidence of growing societal concerns about some aspects of technological fixes. Such concerns deserve to refocus the discussion begun by Weinberg fifty years ago.

Critical assessments of technological fixes have variously identified reliance on technological solutions as evidence for inadequate engineering practice, failures of government policy, or outcomes of modern consumerism. These concerns suggest that technological fixes have important implications for shared social values, the wellbeing of wider publics, and the social role of engineers. In short, technological fixes have cultural, ethical and political dimensions.

Cultural Losses of Faith in Technology

Like expressions of technological faith, critiques of technology have grown around particular examples. As early as the 1960s, opponents of the Vietnam War cited the impotence of high-technology military systems against the guerilla methods of a resourceful enemy [40]. If high technology can be negated by such social and political opposition, this seemed to suggest, why should technological fixes be trusted as a panacea for social and political problems?

For urban audiences over the same period, nuclear technologies were increasingly cited as inherently dangerous. For growing numbers, the field represented a failure of government-managed safety certification procedures and a secretive industry. Similarly the chemical industry, which had once been praised for technological fixes such as DDT to kill agricultural pests and assure high crop yields, was now criticized as the source of widespread ecological damage [41]. Such technological criticism in America was pointed to catastrophes such as super-tanker spills[9] as representative of decision-making that prioritized the global petrochemical economy. And while human health remained the domain of technological fixes evincing the most widespread optimism, some topics raised growing disquiet among consumers. Among them was an entirely new field for technological fixes: genetic engineering to design foods that could be longer-lasting or more nutritious (but not necessarily tastier), or to cure inherited illnesses or extend human choices (but also introducing myriad moral questions alongside these new powers). Such cases were cited to argue that technological solutions streamlined analysis, prioritized economic, corporate, or consumer interests rather than wider benefits, and under-estimated societal side-effects.

Ethical Implications

Early scholarly criticisms of Alvin Weinberg's notions criticized them as naively confident about the outcomes of science ("scientistic") and tending to narrowly define the complexity of problems ("reductionistic") [42]. Because of its exaggerated attention to measurable outcomes, rational decision-making carries additional philosophical and ethical dimensions. This confidence in positivism prioritizes confidence in quantitative evidence, and necessarily devotes less consideration to aspects of human values that cannot be counted.

[8]Engineering disciplines have adapted to the contemporary environment of terrorist threats by creating special-interest groups to promote security technologies and funding for technological fixes. Among them is the Homeland Security group of SPIE, the optical engineering society, which aims to "stimulate and focus the optics and photonics technology community's contributions to enhance the safety, counter homeland threats, and improve the sense of well being" [38].

[9]International incidents included spillages from the oil tankers *Amoco Cadiz* (1978) and *Atlantic Empress* (1979). Later incidents, such as the *Exxon Valdez* (1989) and *Deep Water Horizon* (2010), fueled public debate about societal reliance on large-scale technological systems, ironically while promoting technological fixes for avoiding or cleaning up after such accidents.

The focus on outcomes also identifies the link between technological fixes and utilitarian ethics, in which the goal is to maximize positive consequences ("the greatest good"). This ethical framework works well for purely engineering problems, but can disfavor groups or environments that are not identified as the intended beneficiaries ("the greatest number"). There are other ethical alternatives for judging responsible innovation: notably duty-based ethics (deontology) and virtue ethics, which instead focus on rights and on personal behaviors, respectively.

The narrowing of analytical dimensions (reductionism) is particularly dangerous when problem-solving relies on technological fixes: how can we adequately assess whether a solution satisfies the unvoiced or inexpressible wishes of all those affected? The problem becomes acute when we consider communities, species and environments without a voice.

Philosopher Arne Naess criticized such ethical implications of relying on technological solutions. He argued that popular enthusiasm for such fixes tended to prioritize the status quo, i.e., the interests of current ways of life, and particularly current socio-economic conditions and interests. Naess argued that technological fixes carried cultural presuppositions about what was "reasonable," and consequently framed problems narrowly. They generally underestimate the scale and nature of socio-technical problems and the potency and side effects that engineering solutions can offer. Naess called short-term environmental attentions and technologically-oriented solutions *shallow ecology*, and offered his own *deep ecology* approach in its place. Naess's alternative analysis sought to consider social, cultural, and technological solutions in tandem, and identified technological fixes as simplistic and inadequate [43].

Along the same lines, economist Ernst Schumacher defined *appropriate technology* as morally responsible innovation that takes equal account of local social needs, resources, labor, and skills in ways that most technological fixes do not. He argued that popular engineering criteria such as efficiency, elegance, and versatility could work against creating a genuinely sustainable sociotechnical system. Schumacher sometimes referred to his approach as "Buddhist economics," in the sense of incorporating moral and social values into modern systematic problem-solving in much the way that some eastern theologies did [44].

For an even wider range of theorists, the technological fix was portrayed as hubris, or excessive confidence, regarding human abilities to adequately understand and manage society and nature through rational means. As a "band-aid" solution to problems involving sophisticated systems, technological fixes were argued to both underestimate and inadequately solve complex problems. Philosopher Alan Drengson, for example, explored the moral values and religious underpinnings of these wider critical perspectives [45], [46]. He argued that technological fixes were too often short-term and incomplete, and consequently could camouflage the ultimate sources of larger problems and the nature of genuinely satisfactory solutions.

Alongside unreflective acceptance of clever technological solutions for urgent problems, there is evidence of growing societal concerns about some aspects of technological fixes.

The Role of Engineers in Democratic Society

The faint voices of the beneficiaries — and potentially victims — of technological fixes are of some concern. For Howard Scott's technocrats, engineers were expected to replace inexpert policy-makers, politicians, and economists by a "technate," or technological government. For Weinberg, government-assigned teams of engineers would assume responsibility for addressing social problems for the national good. For Meier, the process of directing technical solutions was envisaged as cooperation between engineers and communities, but ultimately guided by those with expert knowledge.

Such management by elites might be assessed and even voted upon by wider audiences, but this consultative process to some extent undermines the special role of technological competence in such a rational society. The effects of public participation in engineering solutions raised mixed feelings for Alvin Weinberg, who observed that some of his technological solutions were unlikely to succeed in a liberal democracy, and that "nuclear energy seems to do best where the underlying political structure is elitist" [47].

The same issues may disempower communities or individual consumers who opt for technological fixes. They may fail to identify how the "problem" and "solution" have been framed by the designers, companies, governments, or media sources who promote them. As a result, the "solutions" they are offered may be shallow or off-target, and reproduce undiscerning cultural values.

Engineers consequently have important responsibilities regarding technological fixes. Designers need to pay close attention to the scope of their analysis and longevity of their solutions. They must consider not just the intended beneficiaries (e.g., customers, clients, funders) but also non-beneficiaries and "externalities" (e.g., marginal social groups, future generations, other species, and distant environments). Most importantly, they should recognize that complex modern societies incorporate multiple values and forms of expertise. Modern problems cannot be reduced to mere engineering solutions over the long term; human goals are diverse and constantly changing.

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