THE PROGRESSIVES' CENTURY

POLITICAL REFORM, CONSTITUTIONAL GOVERNMENT, AND THE MODERN AMERICAN STATE

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The Progressives' Deployment of Expertise and the Contemporary Faith in Science to Grow the Economy and Create Jobs

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The Progressives were well known for their rational deployment of expertise in government and for advocating the federal government's use of science to solve pressing national problems. But do federal policy makers promote expertise rationally today? Has a faith in science become a blind faith—an unscientific hope to have science and engineering magically rescue us from our ills?

Consider the American politics of science in the 2000s. Political leaders, especially presidents but others as well, are very public subscribers to a seemingly simple causal theory. Their statements suggest that natural science, and thus scientists, produces technological innovation, and that innovation leads to jobs, economic growth, national competitiveness, and national security. The argument seems obviously true—one can easily name a new technology that fostered job and wealth creation (for example, consider how Apple's iPhone created a whole new economy in "app" development). Presidents, including Barack Obama and George W. Bush before him, have thus argued for increased spending on basic scientific research in universities, increased domestic production of scientists and engineers, and increased immigration of scientists and engineers to universities and tech companies. If science and scientists produce innovation, and innovation produces so many wonderful things, then the more we have, the better off we will be.

Yet we know surprisingly little about how this causal theory works. There is, to be sure, a large and vibrant literature, especially in economics, management, and history, regarding technological innovation.[1] This work, however, does not provide a clear foundation for the causal theory common in contemporary policy discourse. Critics are alert to the problem. They recognize that we are almost completely in the dark when it comes to assertions about how greater investment in scientists and engineers works to foster more national growth.[2] This critique has reached into the highest offices of state. John Marburger III, George W. Bush's director of the Office of Science and Technology Policy and a former director of the Brookhaven National Laboratory, argued that the whole science policy enterprise was severely limited by a lack of data or evidence to support its basic conclusions. In one essay, he argued that even comparing the numbers of engineers in the United States with those in other countries—a practice that had driven policy here for half a century—made little sense because of difficulties in cross-national comparisons.[3] Marburger ultimately called for a "science of science policy" because of the evident failure to set policy in rational ways. As he later wrote, "My policy speeches from 2005 and thereafter expressed my frustration over the inadequacy of data and analytical tools commensurate with science policymaking in a rapidly changing environment."[4]

The absence of a science of science policy is no small irony. A causal connection between science and technology on one hand and job and wealth creation on the other is clear in presidential speeches, policy guidelines, and legislation. It drives much of the contemporary enthusiasm for immigration reform. But in the face of critiques pointing to the holes in the argument, policy makers' call for more science does appear to have become a matter of blind faith, a faith that resembles alchemy more than it resembles the Progressives' rational deployment of scientific expertise.

Specifically, there are three problems with faith in this causal connection. First, we do not know which branch of science should be receiving the most political attention and governmental investment. Which scientific fields are most likely to produce job-creating innovation? Policy makers have not even asked this question, let alone answered it.

Second, we do not know who is most likely to produce this innovation. While there are calls for increased immigration of scientists and engineers, does that mean more electrical engineers or mechanical engineers, more biologists or botanists? Which kind of science and engineering professional is most likely to innovate and produce jobs? What is the optimal ratio of scientists to engineers? Even more basically, policy makers are fond of using the acronym STEM, which refers to science, technology, engineering, and math, and to call for more STEM workers. This sounds clear enough until we try to define exactly what is included in these terms or even to specify the needed level of degree (Ph.D., M.S., B.S.—or even something less rigorous?)—which is almost never even attempted.

Third, we do not know when a causal connection actually exists. Does technological innovation always produce (good) jobs in America, and if not, under what conditions does it produce good jobs in America? How does the number of new science and technology positions affect the amount of innovation? Economists have long argued that technological innovation produces jobs, and better jobs than previously existed. Yet there are some who argue that this connection is breaking down, primarily because of advances in robotics and artificial intelligence.[5] It is not even clear what counts as "innovation," and whether the most valuable innovations really produce the most jobs.[6] The argument for recruiting more technical talent has, however, long since taken on a life of its own.

This chapter does not provide the missing link, a nuanced causal theory of the relationship between scientists and national performance. Instead, it details the historical developments that have gradually obviated any perceived need for such a theory. Contemporary political rhetoric expressing a faith in a hypothesized (yet little understood) causal connection between scientific expertise and jobs and wealth creation—part of what Daniel Sarewitz has astutely called "the myth of infinite benefit" of science[7]—has roots in Progressivism. It also marks a significant transformation of the Progressive vision of how the federal government should use the natural sciences. Even as Progressives embraced vague and sometimes contradictory impulses and beliefs,[8] Progressive governance sought social betterment primarily through the use of *existing* scientific expertise to achieve specific, identified goals.[9] The Progressives' typical use of science was to develop standards and measures (for example, to ensure safe food). What constituted success for the Progressives might have been a reduction in illnesses due to impure food, or the number of specific experts housed in a bureau with a defined mission. Recent decades, however, have seen the rise of vaguer measures of success—the *overall* number of scientists and engineers, working in *any* field, or the overall number of federal dollars allocated to research.

The movement from the Progressive approach and toward an unmoored enthusiasm advanced in stages, each characterized by competitive pressures. In the first stage, the federal government significantly ramped up its investments in science as part of the effort to win World War II. In the second stage, corresponding to the 1950s and the Cold War, policy makers focused on the number of scientists and engineers as an indicator of national security preparedness against the Soviet Union. In the third stage, occurring mostly in the 1980s, policy makers shifted the rationale from security to economic growth and to concerns over Japan's economic might, which was built on science and engineering. In the fourth stage, from the 1990s to the present, a clear competitor is no longer on the horizon, but a pervasive sense of threat remains, and so policy makers have begun to focus on importing foreign science and engineering workers through immigration. Over time, the original impulse to use scientific expertise to solve some specific problem at hand has spun out visions ever more general and abstract. In the absence of a foreign competitor or any single benchmark, the dominant argument now is that the more scientists and engineers there are, the greater their economic magic: more innovation, more economic growth, and more job creation. The key to all good things, science has shed its progressive realism to become the government's fantasy elixir.

Politics, not measured scientific analysis, drove these transitions. Political elites who really believed in the powers of science—or who simply sought votes and power—used their positions to pursue opportunities created by perceptions of threat (specifically, threats created by wars—hot, cold, and trade).[10] They pushed the Progressives' limited and specific use of scientific expertise into greatly expanded and mostly unjustified directions. Once established in the culture, faith in the power of science proved useful for a variety of political elites. Science administrators have used it to seek more resources and more discretion to use those resources. Members of Congress have used it to sell hope to the voters and gain the support of key constituents. And scientific and tech industry leaders have used it to gain more resources and to promote specific regulatory changes, including in the area of immigration policy.

The Progressive Approach to Government and Science

Federal support for science and engineering's cornucopia is a staple of presidential speeches today, and one can find a faith in science for progress, and a stress on training for scientific competence, in writings going back to Jefferson, Franklin, and others who worked to found the nation.[11] The Constitution recognizes the benefits of scientific progress and authorizes Congress to create incentives for inventions by establishing copyright and patent protection. But it did not explicitly authorize Congress to do science or make scientists.[12] It was by no means a smooth path to the perspective adopted today, the urgent, open-ended, and unexamined push for more scientists and engineers.

The Progressive vision of government is perhaps best known for its focus on rational management. The "search for order" that Robert Wiebe described referred to a state of continual management by experts.[13] "Efficiency" became a goal and even a virtue in countless contexts, and Progressives used science and engineering as part of this pursuit of rational management, focusing on the ability of scientists to solve specific problems that drew on existing expertise. The Progressives' desire to use natural science, as well as the growing social sciences, to create standards and improve efficiency was often misguided.[14] It was perhaps at its worst and most destructive on matters of race and ethnicity.[15] Consider the rise of eugenics during the period,[16] or firms' use of the rational management of ethnic stereotypes ("racial adaptability") to promote efficiency and profits.[17] In the area of immigration, Progressives employed rational management to improve America by building on traditions of excluding unwanted races, ethnicities, and religions, as well as refining exclusions of those with mental and physical disabilities.[18] The Progressive approach of using immigration policy to *exclude* the undesired, rather than to *attract* the desired, contrasts starkly with the current era (see below).

But the Progressives' faith was directed at clearly articulated problems. The late 1800s also saw the federal government's growing faith in and reliance on existing expertise in agricultural, chemical, and other natural sciences. Experts, often housed in new bureaus, typically deployed routinized skills to test and apply standards to ensure safety and uniformity.[19] Their purpose was to assist ongoing commercial enterprises, often in rural areas, rather than to generate new industries. For example, the Hatch Act (1887) established experiment stations to test and develop fertilizer.[20] The Bureau of Mines facilitated extractive industries and sought to make mines less dangerous; the Bureau of Entomology helped farmers control pests; and the Bureau of Animal Industry worked to control diseases affecting livestock.[21] Progressives also brought the federal government's facilitating role in science to mass consumers and industrialization. In the early twentieth century, the Bureau of Chemistry began a rapid expansion of its duties concerning testing the safety of food.[22] By 1916, the Bureau of Standards, in the words of the historian A. Hunter Dupree, had become "a direct link between government and industry," though "usually staying in the background."[23]

The federal government rarely conducted original research (which was occurring in the nation's growing research universities), nor was it involved in the creation of scientists and engineers.[24] World War I did foster new direct research by the federal government in specific projects designed to win the war.[25] When the war ended, however, there was a return to a hands-off approach. America's scientists preferred a decentralized structure in order to preserve their autonomy. They resisted an effort to make the National Research Council a permanent scientific coordinating agency; accordingly, it simply advised the government and became a distributor of funds from the Rockefeller and Carnegie Foundations for postdoctoral fellowships and various projects.[26]

The Progressive approach, then, was an abiding though limited faith in the government's use of science to solve existing problems, combined with a decentralized organizational structure that left basic science research to universities and private foundations. A rapidly growing number of corporate laboratories took on the task of applied research (corporate labs grew from 300 in 1920 to 1,624 by 1930, when they employed about 34,000 workers).[27]

In retrospect, however, the rhetoric of Progressivism may have been as important as the reality, for the reform movement did affirm the power of science to provide amazing, unimagined public benefits.[28] W. J. McGee, a prominent Progressive-era geologist and conservationist, put it this way: "America has become a nation of science. There is no industry, from agriculture to architecture, that is not shaped by research and its results; there is not one of our fifteen millions of families that does not enjoy the benefits of scientific advancement; there is no law on our statutes, no motive in our conduct, that has not been made juster by the straightforward and unselfish habit of thought fostered by scientific methods."[29] In the 1920s, Herbert Hoover, the secretary of commerce under presidents Harding and Coolidge and a former mining engineer, began to promote investment in basic science. He argued that both "pure and applied scientific research" were "the foundation of genuine labor-saving devices, better processes and sounder methods,"[30] and complained in 1925 that $200 million was spent on applied science, but only $10 million on basic science, though "the raw material for these [applied science] laboratories comes alone from the ranks of pure science."[31] McGee's and Hoover's faith in science would find more advocates as the twentieth century advanced.

Stage 1: World War II and the Permanent Federal Role in Science

Although the Progressive era brought new roles and renewed faith in science and engineering to the federal government, it was (in the words of the historian Brian Balogh) the "triple crises" of the Depression, World War II, and then the Cold War that fully institutionalized the federal role in scientific research and the formation of the science and engineering workforce.[32] Scientists and engineers would help set the science agenda, which would direct federal resources, and the federal administrative apparatus would aid in implementation. A symbiotic relationship developed between professional experts and public bureaucracies.

World War II was perhaps the most important proving ground for the role of science—when directed by the federal government—to serve the national interest. The war was a key impetus in the creation of a system of national laboratories, which did basic science but concentrated on national security and weapons research.[33] It was also a spur to the creation of the National Science Foundation (NSF).[34]

A major force shaping the NSF was Vannevar Bush, an electrical engineer and inventor. From 1938, Bush was a member of one of the few federal science agencies, the National Advisory Committee for Aeronautics. From this position, he was able to convince President Roosevelt to establish the National Defense Research Committee to coordinate research on war technologies in 1940 (with Bush in charge), and in 1941, Roosevelt appointed Bush head of a larger organization: the Office of Scientific and Research Development. The focus remained on war technologies, including the Manhattan Project, but the name denoted a broader mission.

As the war drew to a close, Bush penned an influential report, *Science: The Endless Frontier*, in which he advocated for the creation of the NSF, or what he then called the National Research Foundation. Roosevelt had asked Bush to explore how the federal government could "profitably" use the wartime research infrastructure in times of peace.[35] Bush maintained that the federal government had key roles to play in the support of basic science research in nonprofit institutions; industry could not be counted upon to make these investments in a timely matter, because of their noncommercial nature. The federal government also needed to support the development of a scientific workforce (through the provision of fellowships) and—of course—continued military research. Bush eloquently stated the causal connections between science and engineering, the associated workforce, and innovation and job creation. In a section of the report entitled "Science and Jobs," Bush wrote:

> We will not get ahead in international trade unless we offer new and more attractive and cheaper products.
>
> Where will these new products come from? How will we find ways to make better products at lower cost? The answer is clear. There must be a stream of new scientific knowledge to turn the wheels of private and

> public enterprise. There must be plenty of men and women trained in science and technology for upon them depend both the creation of new knowledge and its application to practical purposes.
>
> More and better scientific research is essential to the achievement of our goal of full employment.[36]

Here was a clear break with the Progressive use of government and science. Rather than deploy existing expertise to solve specific and limited problems, Bush advised the government to *create* expertise, and the expertise to be created was to be used in *unknown* ways to develop *unknown* products.

Stage 2: Keeping the Science and Engineering Score During the Cold War

In 1906, President Theodore Roosevelt said to the nation: "Our federal form of government, so fruitful of advantage to our people in certain ways, in other ways undoubtedly limits our national effectiveness. It is not possible, for instance, for the National Government to take the lead in technical industrial education, to see that the public school system of this country develops on all its technical, industrial, scientific, and commercial sides."[37] In the 1950s, the obstacles to a federal role in creating a science and engineering workforce that concerned Roosevelt, as well as Vannevar Bush, were swept away.

The vitality of scientific research and the size of the science and engineering workforce became national crises during the Cold War struggle with the Soviet Union. In the absence of direct confrontations on the battlefield, policy elites as well as journalists looked to other measures to see who was winning. In doing so, they contributed to the simplistic causal theory that science and scientists in some magical way led to innovation and the good things that innovation produced—and in these years, those good things were related to national security. Simple science-oriented scorecards became a way to assess America's prospects in the Cold War.

One scorecard was funding for research and development (R&D). The Department of Defense started to measure research investments in 1953, finding that 1952's total included $3.75 billion, or 1 percent of the gross national product, and that the federal government footed the bill for 60 percent of it. The NSF then began to regularly score the United States on R&D, though this was understood as part of the overall innovation system rather than as only a measure of defense and preparedness.[38]

Though experts such as Lee DuBridge, then president of the California Institute of Technology, argued against it, the *number* of scientists and engineers also became part of the scorecard and a measure of innovative capacity.[39] Multiple studies, from sources with close ties to the federal government, sounded the alarm that the Soviet Union was creating many more science and engineering workers than the United States. By 1955, it appeared that the USSR was graduating about 95,000 engineers and applied scientists per year, while the United States lagged far behind at about 57,000 per year. In 1954, even before these figures were published, the *New York Times* learned of the deficit and put on its front page a story announcing, "Russia Is Overtaking U.S. in Training of Technicians."[40] Secret CIA testimony confirmed the threat of the "manpower gap."[41]

Into this context emerged *Sputnik*, the first man-made satellite, launched by the Soviet Union in 1957. *Sputnik* shocked the world—especially U.S. science and engineering policy makers. To American policy elites keeping score in the science and engineering race, *Sputnik* looked like a walk-off home run in the World Series. The climate of urgency and crisis ratcheted up, and it changed the politics of education and science forever.

A federal role in education had been thwarted for decades. There were three major forces against a federal role in education: critics who argued that education was properly a matter of local control; conflicts regarding the issues of how to manage the southern states' de jure segregated schools; and concerns related to governmental funding of parochial schools.[42] But an urgency born of the need for national security ended all that.[43]

The National Defense Education Act of 1958 stated in its preamble: "The security of the Nation requires the fullest development of the mental resources and technical skills of its young men and women. . . . The national interest requires . . . that the federal government give assistance to education and programs which are important to our national defense."[44] The law provided loans to college students, funds to improve science and engineering education, and National Defense Fellowships. Although the law was not limited to science and engineering, that area was a major focus, and another statute, the National Aeronautics and Space Act of 1958, contained provisions to recruit new science and engineering talent to serve the national interest.[45]

By 1959, the federal government's leading role in the advance of science was unquestioned, and scorecard thinking of "the more, the better" was unexceptional, even by Republicans. When signing an executive order creating the Federal Council for Science and Technology, President Dwight D. Eisenhower approvingly cited growing funding for R&D, stating, "It is the responsibility of the Federal Government to encourage in every appropriate way the scientific activities of non-Government institutions."[46]

The Cold War competition with the Soviet Union also spawned the deployment of scientists to create a new kind of expertise: the ability to travel to the moon. While this involved a specific goal, the "space race" empowered science-funding advocates, who began to voice a faith in science to produce unknown wonders. For example, Hugh Dryden, the deputy director of the new National Aeronautics and Space Administration, told the Senate Committee on Appropriations that space technology would benefit all Americans in unknown ways through "a great variety of new consumer foods and industrial processes that will raise our standard of living and return tremendous benefits to us in practically every profession and activity."[47]

Stage 3: Numbers of Science and Engineering Workers, the Japan Threat, and the "Pipeline Problem"

By the 1970s, national competitiveness joined national security as justifications for large but ill-defined investments in R&D and the science and engineering workforce. President Nixon announced this shift in a special message to Congress on science and technology, promising the formation of federal policy to foster "innovation" and its resulting cornucopia of goods.[48] The discourse of economic competition became more prominent in the 1980s as Japan became a technological and economic powerhouse.[49] Responding to Japan proved to be good politics. Congress moved into action, and bills were submitted in the House with names like "National Engineering and Science Manpower Act of 1982" and "Emergency Mathematics and Science Education Act of 1983."[50]

These efforts emphasized engineering and technology (more than basic science research), and were meant to compete with Japan's perceived strength in these fields. A new focus on higher education aimed to facilitate innovation in the nation's research universities by making it easier for universities to patent innovations (the Bayh-Dole Act of 1980).[51] The NSF created sites where universities and firms could collaborate on research, such as the 1985 program for Engineering Research Centers.[52]

The conviction that science could set things right continued to substitute for precise policy and verifiable outcomes. One failed bill aimed to establish a National Technology Foundation to spur innovation and the human resources to create it. In 1980 hearings for the bill, advocates emphasized that innovation fostered job creation, among other benefits: "The development of new technologies promises fuller national employment . . . new goods or services for the national welfare . . . [and] existing goods and services at lower costs." With a focus on technology and engineers, the NTF would be an important counterpoint to the NSF, which, advocates claimed, had neglected both.[53]

Although the bill failed, its impact was felt. Lewis Branscomb, the chair of the National Science Board, which oversaw the NSF, and also a vice president and the chief scientist at IBM, was sympathetic to the goals of the proposed NTF. Branscomb added his voice to groups such as American Association of Engineering Societies and the American Society of Engineering Education to call for more engineers while emphasizing their power to boost national competitiveness.[54] Branscomb's National Science Board reoriented the NSF to deal with the perceived crisis, issuing an unnerving statement: "The United States is at a critical juncture in its industrial leadership. Not since Sputnik in 1957 has there been so much cause for concern about the adequacy of our science and technology base and our ability to capitalize on our scientific strengths to sustain industrial leadership. We face foreign competitors who have growing skills, lower costs, and higher productivity growth. These factors affect the security of our Nation, the standard of living of our people, and our legacy for future generations."[55]

In 1982, Douglas Pewitt, the assistant director for science policy at the Office of Science and Technology Policy, requested that the NSF study its data collection on science and engineering in order to identify possible shortages, and the NSF responded with a report in 1984 on the science and engineering labor market, reinforcing the notion of such workers' role in innovation.[56] An even bigger boost was the highly publicized report of the National Commission on Excellence in Education, ominously titled *A Nation at Risk*. It warned that American preeminence in science and technological innovation (among other things) was being lost because of mediocre education.[57]

Although Democrats and Republicans differed on the means, they seemed to agree that more science and engineering workers were needed to ensure the nation's competitiveness. The simplistic assessment of America's capacity for innovation—counting the number of science and engineering workers—that had marked the run-up to the National Defense Education Act found new life, but now the comparisons were with Japan rather than the Soviet Union. In a Senate hearing in 1982 on authorizing the NSF, Senator Edward Kennedy (D-Massachusetts) stated:

> The Japanese now have doubled the number of engineering graduates in the last 10 years. We have held about level. . . . We see the movement of R&D in the military area that is again going to draw [engineers] from the civilian area. I think that what we need are some flow charts and flow lines of what the implications of this are going to be in terms of our economy, in terms of jobs, where we are going to be internationally over a period of time. [. . .] There is a flow line that is taking place in our society, and I think there is an agency that has to awaken this country as to what our needs are going to be.[58]

Similarly, the moderate Republican Margaret Heckler of Massachusetts stated at a House hearing:

> I feel we are frightfully behind. . . . Now we know that on the one hand we have the technology problems, the personnel problems, the academic training needs, the productivity lag between the U.S. and Japan, all these enormous difficulties facing the industry and jobs affected by it, and here we have an enormous resource in the population of women and minorities and we do not really seem to be making the right linkages.[59]

President Ronald Reagan, when proposing to double the budget of the NSF, did not express fright, but he did share the lead-into-gold alchemical vision: "Science and technology are fundamental to U.S. competitiveness. . . . But, we must recognize that our trading partners, in their desire to improve their standards of living and market share, are catching up. We must ensure that adequate incentives are in place that will not only maintain our preeminence in initiating ideas and know-how, but also our lead in setting the pace at which these are translated into new products and processes."[60]

Other respected voices in national science policy contributed similar arguments. The National Research Council formed its Committee on the Education and Utilization of the Engineer (with the NSF director, Erich Bloch, an electrical engineer who had worked under Branscomb at IBM as vice president for technical personnel development,[61] as a member). In 1985 and 1986, this committee issued reports continuing the drumbeat of support for more bodies in the engineering pipeline, and attempting elaborate and (ostensibly) scientific modeling of the engineering supply infrastructure.[62] At this point, the metaphor of a pipeline became more common in the discourse. The perceived problem was limited and undirected flow; creating a pipeline would deliver more bodies to perform more (unspecified) scientific work to achieve American goals of economic competitiveness.

Bloch worked to reorient the NSF to pursue the problem of the science and engineering pipeline. Part of this effort involved issuing more reports on the problem. He directed the NSF's Policy Research and Analysis Division (PRA) to educate the public about the need for large numbers of new scientists and engineers in order to maintain American competitiveness. The premise of this enterprise also focused on the pipeline flow of students moving through the educational system toward science and engineering careers. The policy challenge was to encourage more of them to enter the pipeline (especially those from underrepresented groups, which primarily meant women and minorities), and then to encourage more to stay rather than to leak out in high school, in college, or in graduate degree programs.[63]

Congress kept up the pressure to bring more women and minorities into the science and engineering pipeline. In 1986, it passed legislation creating the Task Force on Women, Minorities and the Handicapped in Science and Technology.[64] Its report, published three years later, sounded the decade's usual tones of alarm and threat: "It is time for action. Our Interim Report and many other studies have detailed the looming crisis in the science and engineering workforce. America faces a shortfall of scientists and engineers by the year 2000. We can meet these shortfalls only by utilizing all our talent, especially those traditionally underrepresented in science and engineering—women, minorities and people with disabilities. Without this kind of world-class science and technical excellence, America's competitive prospects dim."[65]

During the 1980s, then, American political elites expressed what one observer called "an almost religious belief" in the power of science and technology to produce wonders.[66] Experts paid little or no attention to which fields were most important for innovation, nor was there any serious attempt to understand how numbers translate to innovation rates, or how salaries might affect the pipeline flow. Moreover, a 1992 congressional investigation found the PRA's analysis claiming a shortage of science and engineering workers to be badly flawed methodologically and incorrect in its conclusions.[67]

Stage 4: Immigration as the Source of Innovation, Growth, and Jobs

In the latest stage, the 1990s to the present day, the movement away from the Progressive vision has reached a high point. Advocates for science and engineering today need not have in mind specific, existing expertise to deploy (which was the Progressive vision). They need not align the creation of new experts with specific problems that need to be solved (which had been the prominent World War II approach). And they need not have specific security or economic threats to serve as prods (as in the Cold War and during the competition with Japan). Moreover, unlike the Progressives, who sought to foster national development by excluding certain immigrants, advocates in government and in industry now seek to improve America by attracting immigrants with science and engineering skills.

Congress had used immigration policy to attract skilled immigrants in the Immigration and Nationality Act of 1952, which set aside visas for immigrants with "urgently needed" skills, including those with technical training.[68] Yet there is little evidence that policy makers saw immigration policy as a major source of science and engineering workers in the 1950s, and the Hart-Cellar Act of 1965, which profoundly remade immigration policy, gave far more priority to immigrants reunifying their families than to those with job skills of any kind.[69]

Congress began to rectify this situation with the Immigration Act of 1990. This legislation created the H-1B visa for skilled workers and offered means for making skilled workers permanent residents by offering green cards.[70] Urged on by industry lobbyists, the law had bipartisan support and was made possible in part by Senator Edward Kennedy's continued interest in the issue.[71]

This mobilization of immigration policy as part of the struggle to increase the numbers of science and engineering workers was a new stage in a decades-long process. By the 1990s, concerns about the Soviet Union were gone; with the collapse of the communist regime, Russians figured into the debates about American science policy less as a competitor and more as a source of talent. Russia was hemorrhaging scientists, and foreign countries and universities sought to acquire Russia's best and brightest.[72] The Japanese threat was also fading. But the momentum was not arrested. By this time, a group of industry lobbyists within the National Association of Manufacturers (later known as Compete America) joined with the American Immigration Lawyers Association and information technology companies to agitate inside the Beltway for more H-1B visas.[73]

The politics of expertise, by this stage, and especially in the 2000s, ran on free-floating anxiety. Arguments for increasing the number of science and engineering workers became more abstract. Although China emerged as a new threat, in most of the discourse of the period the United States was competing against no one in particular, but everyone in general. There were no firm standards for success, and no clear goals for policy. The old equation of "science produces innovation, which produces jobs" held strong, but at least as it regarded science and engineering workers, the only rationale was the more, the better.

The buzzword of official reports in the 2000s was "innovation." The word took center stage in the economic rhetoric and policy proposals of presidents George W. Bush and Barack Obama. Innovation would keep America ahead of the pack and dispel fears of national decline. In 2005, a bipartisan group of senators asked the National Academies of Science, Engineering, and Medicine for a report and list of recommendations "to enhance the science and technology enterprise so that the United States can successfully compete, prosper, and be secure in the global community of the 21st century."[74] The report, titled ominously yet hopefully *Rising Above the Gathering Storm*, (not surprisingly) called for more science and engineering workers and also for immigration reform to attract them. Congress responded in 2007 with the America COMPETES Act, which authorized more investments in science and engineering, though funds did not flow until 2009.[75] Nevertheless, a follow-up report, *Rising Above the Gathering Storm, Revisited*, had an even more ominous subtitle: *Rapidly Approaching Category Five*.[76]

In 2013, the Senate passed a comprehensive immigration reform bill that grouped several immigration issues together. Most prominent in the public debate was a legalization package for approximately eleven million undocumented immigrants, combined with increased security at the border and the imposition of new requirements on employers to ensure they were not hiring undocumented immigrants. But to secure the support of business, especially in the tech sector, the reform package included an expansion in the number of H-1B visas. Another sweetener for businesses was a provision mirroring a bill that had floated around Congress for years, the so-called STAPLE Act. This bill was so named because it would metaphorically staple a green card to the diploma of any foreign student at an American university who was earning an advanced degree in science, technology, engineering, or math, and who had a job offer. Since the 1990s, these fields were increasingly grouped together, first with the acronym SMET, and then referred to as STEM. Despite offering the very valuable green card to foreigners with STEM degrees and the potentially large impact on graduate schools and labor markets, the Senate bill not only did not identify which degrees were most valuable to innovation and economic growth, but did not even define STEM.[77]

Advocates for increasing the science and engineering workforce have used the mass media to promote immigration of the highly skilled. The op-ed pages have been filled with arguments such as that of Steve Case, the former CEO of AOL and a major force behind the "Startup Act," which, much like the STAPLE Act, sought to give permanent residency to fifty thousand noncitizens who earned master's or doctorate degrees in a STEM field. Case equated the number of science and engineering immigrants with innovation. He brought back the old international comparisons and numerical benchmarks, arguing that the United States was falling behind, in various ways, Germany, China, Canada, and Australia (for example, "Australia—despite having an economy 14 times smaller than America's—will, as of Sept. 1, offer as many employment-based green cards as the U.S."). Case made dire warnings of imminent peril, linking skilled immigrants with jobs: "Will we win this global battle for talent—successfully recruiting and retaining the men and women who start American companies that create jobs, who drive innovation forward with creativity and expertise, who power these economic engines with their drive and passion?"[78]

Business interests have become involved in various ways, making similar arguments. A group of tech businesses formed a group to lobby for the science and engineering workers that the immigration reform bill would provide, calling itself the March for Innovation.[79] The American Association of Universities and the Association of Public and Land-Grant Universities sought to promote a problem they called the "innovation deficit," which could be measured by relatively low figures for R&D investment and the number of science and engineering students. Another part of the problem was declining numbers of foreign students in science and engineering: "Even though the number of international students attending U.S. universities increased between 2000 and 2011, the U.S. share of total international students declined by more than 25%. Meanwhile, nations like Germany, New Zealand, and the UK have seen significant increases both in numbers and in total share of international students during this time."[80] Compete America launched a "jobs lost calculator" that purported to show not just the jobs created by more science and engineering workers, but also the jobs lost by Congress's failure to expand the number of H-1B visas. It increased by 1 every sixty-three seconds, and reached 500,000 on April 1, 2014.[81]

Conclusion

The Progressive era's faith in expertise has moved far—very far—from its modest beginnings. Although faith in science to produce benefits through innovation has existed in the United States since the nation's founding, the contemporary period's approach of promoting innovation through unspecified numbers of vaguely defined science and engineering workers developed in four distinct stages, each of which moved policy aims further from the limited and applied Progressive vision. World War II marked the institutionalization of the federal government's role in developing science and engineering, even as this development was limited to solving specific war-related problems. The Cold War began the trend of equating the numbers of science and engineering workers with innovation capacity, and this continued when Japan became the major threat and the goal moved from national security to economic competitiveness. The 1990s and especially the 2000s have marked the latest stage, in which policy makers have sought to increase the numbers of science and engineering workers without any clear benchmark or goal—other than their mysterious ability to (somehow) produce innovation, which in turn produces jobs. Policy as problem solving has become policy as conviction.

There is little reason to doubt that science and engineering—and workers in those fields—*do* produce national security, economic growth, and jobs. But trying to tap this potential without knowing how exactly it delivers benefits has turned science into alchemy. Policy makers push a vision, in effect selling hope to voters, without knowing, much less explaining, how the process works.[82] U.S. science policy has sought to mix a variety of ingredients, including increased R&D funds and outreach to those with an expansive variety of science and engineering skills, in order to produce what Americans want. Although few in the Progressive era would have recognized this approach, and although it took decades and multiple global conflicts to elaborate it, the Progressives' efforts provided a foundation for what has become a policy of faith.

Notes

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1. See, for example, David C. Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth* (New York: Cambridge University Press, 1989); Richard R. Nelson, *Technology, Institutions, and Economic Growth* (Cambridge, Mass.: Harvard University Press, 2005); and Mary Lindenstein Walshok and Abraham J. Shragge, *Invention and Reinvention: The Evolution of San Diego's Innovation Economy* (Stanford, Calif.: Stanford University Press, 2014).

2. Donald Kennedy, Crispin Taylor, Kirstie Urquhart, and Jim Austin, "Supply Without Demand," *Science*, February 19, 2004, http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2004_02_19/nodoi.9424811656219924021. For an analysis of these debates, see Michael S. Teitelbaum, *Falling Behind? Boom, Bust, and the Global Race for Scientific Talent* (Princeton, N.J.: Princeton University Press, 2014).

3. John Marburger III, "Wanted: Better Benchmarks," *Science*, May 20, 2005, 1087.

4. John H. Marburger III, "Why Policy Implementation Needs a Science of Science Policy," in *The Science of Science Policy: A Handbook*, ed. Kaye Husbands Fealing, Julia I. Lane, John H. Marburger III, and Stephanie S. Shipp (Stanford, Calif.: Stanford Business, 2011), 9–29, 14–15. Marburger's tenure in the Bush administration was not without controversy, since he defended an administration that many scientists saw as antiscience, but his calls for a science of science policy have been influential; see Jeffrey Mervis, "John Marburger's Impact on U.S. Science Policy," *Science*, August 1, 2011, available at http://news.sciencemag.org/2011/08/john-marburgers-impact-u.s.-science-policy.

5. See, for example, Eric Brynjolfsson and Andrew McAfee, *Race Against the Machine: How the Digital Revolution Is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy* (Digital Frontier Press, 2012); Eric Brynjolfsson and Andrew McAfee, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies* (New York: Norton, 2014); Martin Ford, *The Lights in the Tunnel: Automation, Accelerating Technology, and the Economy of the Future* (Acculant Publishing, 2009).

6. Facebook, for example, was lauded as an innovative technology company, and was worth more than $100 billion when it employed fewer than 3,500 people. Facebook purchased the photo-sharing app company Instagram for $1 billion when that company employed 13 people; see Evelyn M. Rusli, "Facebook Buys Instagram for $1 Billion," *New York Times*, April 9, 2012, http://dealbook.nytimes.com/2012/04/09/facebook-buys-instagram-for-1-billion/?_php=true&_type=blogs&_r=0.

7. Daniel Sarewitz, *Frontiers of Illusion: Science, Technology, and the Politics of Progress* (Philadelphia: Temple University Press, 1996), 17.

8. See, for example, Daniel T. Rodgers, "In Search of Progressivism," *Reviews in American History* 10 (1982): 113–32, and Peter G. Filene, "An Obituary for 'The Progressive Movement,'" *American Quarterly* 22 (1970): 20–34.

9. In this chapter, we focus only on the natural sciences, and avoid for now the Progressives' enthusiasm for using social science to improve government. On the Progressives and social science, see, for example, Thomas C. Leonard, "Retrospectives: Eugenics and Economics in the Progressive Era," *Journal of Economic Perspectives* 19, no. 4 (2003): 207–24.

10. On the role of war in American state building and policy making, see Ira Katznelson and Martin Shefter, eds., *Shaped by War and Trade: International Influences on American Political Development* (Princeton, N.J.: Princeton University Press, 2002); John D. Skrentny, *The Minority Rights Revolution* (Cambridge: Belknap Press, 2002).

11. Scott L. Montgomery, "Science, Education, and Republican Values: Trends of Faith in America: 1750–1830," *Journal of Science Education and Technology* 4, no. 2 (1993): 521–40.

12. Article I, Section 8 states that Congress has the power "to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

13. Robert H. Wiebe, *The Search for Order, 1870–1920* (New York: Hill and Wang, 1967).

14. Jennifer Alexander, "Efficiencies of Balance: Technical Efficiency, Popular Efficiency, and Arbitrary Standards in the Late Progressive Era USA," *Social Studies of Science* 38, no. 3 (2008): 323–49. Also see Samuel Haber, *Efficiency and Uplift: Scientific Management in the Progressive Era, 1890–1920* (Chicago: University of Chicago Press, 1964). On enthusiasm for the training of engineers, see Christophe Lécuyer, "MIT, Progressive Reform, and 'Industrial Service,' 1890–1920," *Historical Studies in the Physical and Biological Sciences* 26, no. 1 (1995): 35–88.

15. Morton Keller, *Regulating a New Society* (Cambridge, Mass.: Harvard University Press, 1994).

16. Leonard, "Eugenics and Economics."

17. James R. Barrett and David Roediger, "Inbetween Peoples: Race, Nationality and the 'New Immigrant' Working Class," *Journal of American Ethnic History* 16 (1997): 3–44.

18. On racist exclusions, see David FitzGerald and David Cook-Martin, *Culling the Masses: The Democratic Origins of Racist Immigration Policy in the Americas* (Cambridge, Mass.: Harvard University Press, 2014). On other exclusions, see Keller, *Regulating a New Society*.

19. Brian Balogh, *Chain Reaction: Expert Debate and Public Participation in American Nuclear Power, 1945–1975* (New York: Cambridge University Press, 1991); A. Hunter Dupree, *Science in the Federal Government: A History of Policy and Activities to 1940* (Cambridge, Mass.: Belknap Press, 1957).

20. John Hillison, "The Origins of Agriscience, or Where Did All That Scientific Agriculture Come From?," *Journal of Agricultural Education* 37 (1996): 8–13.

21. Dupree, *Science in the Federal Government*, 160–64.

22. Ibid., 176.

23. Ibid., 266–67. On this period, also see David M. Hart, *Forged Consensus: Science, Technology, and Economic Policy in the United States, 1921–1953* (Princeton, N.J.: Princeton University Press, 1998).

24. One historian claimed that the government was only a "reluctant patron of science" until the 1940s; see Harvey M. Sapolsky, "Science Policy in American State

Government," *Minerva* 9, no. 3 (1971): 322. The creation of the science and engineering workforce was left to universities; see Lécuyer, "MIT, Progressive Reform."

25. Roy MacLeod, "Science and Democracy: Historical Reflections on Present Discontents," *Minerva* 35, no. 4 (1997): 369–84.

26. Dupree, *Science in the Federal Government*, 327–29.

27. Ibid., 337.

28. David K. van Keuren, "Science, Progressivism, and Military Preparedness: The Case of the Naval Research Laboratory, 1915–1923," *Technology and Culture* 33, no. 4 (1992): 710–36.

29. Quoted in Dupree, *Science in the Federal Government*, 301.

30. Ibid., 338.

31. Ibid., 341. As president, Hoover would continue to extol the promise of basic science research, stating, "Research both in pure science and in its application to the arts is one of the most potent impulses to progress," and "Our scientists and inventors are amongst our most priceless national possessions"; see Herbert Hoover: "Address on the 50th Anniversary of Thomas Edison's Invention of the Incandescent Electric Lamp," October 21, 1929, at the American Presidency Project, www.presidency.ucsb.edu/ws/?pid=21967.

32. Balogh, *Chain Reaction*, 12.

33. Peter J. Westwick, *The National Labs: Science in an American System, 1947–1974* (Cambridge, Mass.: Harvard University Press, 2003).

34. On the origins of the NSF, see, among others, Daniel Lee Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, N.C.: Duke University Press, 1995).

35. John F. Sargent Jr. and Dana A. Shea, *The President's Office of Science and Technology Policy (OSTP): Issues for Congress* (Washington, D.C.: Congressional Research Service, November 26, 2012), 2.

36. Vannevar Bush (director of the Office of Scientific Research and Development), *Science: The Endless Frontier; A Report to the President* (Washington, D.C.: Government Printing Office, 1945), available at http://www.nsf.gov/about/history/nsf50/vbush1945_content.jsp.

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38. Benoît Godin, "National Innovation System: The System Approach in Historical Perspective," *Science, Technology, and Human Values* 34, no. 4 (2009): 476–501.

39. Teitelbaum, *Falling Behind?*, 34.

40. David Kaiser, "The Physics of Spin: Sputnik Politics and American Physicists in the 1950s," *Social Research* 73 (2006): 1225–52, quotation on 1231.

41. Ibid., 1233.

42. Norman C. Thomas, *Education in National Politics* (New York: McKay, 1975).

43. Barbara Barksdale Clowse, *Brainpower for the Cold War: The Sputnik Crisis and the National Defense Education Act of 1958* (Westport, Conn.: Greenwood, 1981), 9, 59, 63.

44. James L. Sundquist, *Politics and Policy: The Eisenhower, Kennedy, and Johnson Years* (Washington, D.C.: Brookings Institution, 1968), 179; David B. Tyack, *The One Best System: A History of American Urban Education* (Cambridge, Mass.: Harvard University Press, 1974), 275–76; Sidney W. Tiedt, *The Role of the Federal Government in Education* (New York: Oxford University Press, 1966), 30.

45. Pamela Ebert Flattau (project leader), with Jerome Bracken, Richard Van Atta, Ayeh Bandeh-Ahmadi, Rodolfo de la Cruz, and Kay Sullivan, *The National Defense Education Act of 1958: Selected Outcomes* (Washington, D.C.: Institute for Defense Analyses/Technology Policy Institute, 2007).

46. Dwight D. Eisenhower: "Presidential Statement upon Signing Order Establishing Federal Council for Science and Technology," March 13, 1959, at the American Presidency Project, www.presidency.ucsb.edu/ws/?pid=11681.

47. Walter A. McDougall, . . . *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic, 1985), 383.

48. Richard Nixon, "Special Message to the Congress on Science and Technology," March 16, 1972, at the American Presidency Project. www.presidency.ucsb.edu/ws/?pid=3773.

49. On the threat of Japan, see Michael J. Heale, "Anatomy of a Scare: Yellow Peril Politics in America, 1980–1993," *Journal of American Studies* 43 (2009): 19–47.

50. Juan C. Lucena, *Defending the Nation: U.S. Policymaking to Create Scientists and Engineers from Sputnik to the "War Against Terrorism"* (Lanham, Md.: University Press of America, 2005), 84–87; on the House bills, see 122n1.

51. Bhaven N. Sampat, "Patenting and U.S. Academic Research in the 20th Century: The World Before and After Bayh-Dole," *Research Policy* 35, no. 6 (2006): 772–89.

52. Roger L. Geiger and Creso M. Sá, *Tapping the Riches of Science: Universities and the Promise of Economic Growth* (Cambridge, Mass.: Harvard University Press, 2008), 72–74.

53. House Committee on Science and Technology, *H.R. 6910 National Technology Foundation Act of 1980*, 96th Cong., 2nd sess., 1980; Lucena, *Defending the Nation*, 88–89.

54. House Committee on Science and Technology, *Engineering Manpower Concerns*, 97th Cong., 1st sess., 1981, 70; Lucena, *Defending the Nation*, 93.

55. "Statement on the Engineering Mission of the NSF over the Next Decade as Adopted by the National Science Board at Its 246th Meeting on August 18–19, 1983," quoted in Panel on Engineering Graduate Education and Research, Subcommittee on Engineering Educational Systems, Committee on the Education and Utilization of the Engineer, National Research Council, *Engineering Graduate Education and Research* (Washington, D.C.: National Academy Press, 1985), 4.

56. Lucena, *Defending the Nation*, 99; National Science Foundation, *Projected Response of the Science, Engineering, and Technical Labor Market to Defense and Nondefense Needs, 1982–84* (Washington, D.C.: National Science Foundation, 1984).

57. National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform; A Report to the Nation and the Secretary of Education, United States Department of Education* (Washington, D.C.: National Commission on Excellence in Education, 1983). Another influential report came out of a think tank called the Hudson Institute, which argued (with support from the Department of Labor) that America was not prepared for the future. In *Workforce 2000*, the focus expanded from high-end innovation provided by science and engineering workers to include more basic competencies: the spread of technology was changing the nature of work, creating a demand for skilled workers throughout the economy. In this view, American workers lacked the appropriate skills in appropriate numbers, and the problem was particularly acute among minorities, creating a skill mismatch that would limit economic growth and competitiveness; see William B. Johnston and Arnold E. Packer, *Workforce 2000: Work and Workers for the Twenty-First Century* (Indianapolis: Hudson Institute, 1987).

58. Quoted in Lucena, *Defending the Nation*, 102; bracketed ellipsis points added, other ellipsis points in the original.

59. House Committee on Science and Technology, *Science and Engineering Education and Manpower*, 97th Congress, 2nd sess., 1982, 534.

60. Ronald Reagan, Message to the Congress on "A Quest for Excellence," January 27, 1987, at the American Presidency Project. www.presidency.ucsb.edu/ws/?pid=34441.

61. Lucena, *Defending the Nation*, 90.

62. Ibid.; Panel on Engineering Graduate Education and Research, Subcommittee on Engineering Educational Systems, Committee on the Education and Utilization of the Engineer, National Research Council, *Engineering Infrastructure Diagramming and Modeling* (Washington, D.C.: National Academy Press, 1986).

63. Lucena, *Defending the Nation*, 108–12.

64. Pub. L. 99-383, §8, Aug. 21, 1986, 100 Stat. 815.

65. Task Force on Women, Minorities and the Handicapped in Science and Technology, *Changing America: The New Face of Science and Engineering; Final Report* (Washington, D.C.: Task Force on Women, Minorities and the Handicapped in Science and Technology, 1989).

66. David Dickson, *The New Politics of Science* (Chicago: University of Chicago Press, 1988 [1984]), 3.

67. Teitelbaum, *Falling Behind?*, 53; Thomas J. Espenshade, "High-End Immigrants and the Shortage of Skilled Labor," Office of Population Research, Working Paper No. 99-5, June 1999, available at http://westoff.princeton.edu/papers/opr9905.pdf.

68. Immigration and Nationality Act (1952), a.k.a. the McCarran-Walter Act (An act to revise the laws relating to immigration, naturalization, and nationality; and for other purposes), H.R. 13342; Pub.L. 414; 182 Stat. 66; Section 203.

69. Skrentny, *Minority Rights Revolution*, chap. 2; FitzGerald and Cook-Martin, *Culling the Masses.*

70. Espenshade, "High-End Immigrants."

71. Daniel J. Tichenor, "The Politics of Immigration Reform in the United States, 1981–1990," *Polity* 26 (1994): 333–62; Peter H. Schuck, "The Emerging Political Consensus on Immigration Law," *Georgetown Immigration Law Journal* 5 (1991): 1–33; Teitelbaum, *Falling Behind?*, 57.

72. See, for example, the 1990 congressional testimony of William E. Kirwan, president of the University of Maryland, at http://users.nber.org/~peat/ReadingsFolder/PrimarySources/Kirwan.1990.html.

73. Teitelbaum, *Falling Behind?*, 57–58.

74. Committee on Prospering in the Global Economy of the 21st Century, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, D.C.: National Academies Press, 2007), xi.

75. Teitelbaum, *Falling Behind?*, 68.

76. Members of the 2005 "Rising Above the Gathering Storm" Committee, *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category Five* (Washington, D.C.: National Academies Press, 2010).

77. Another immigration-related program does define STEM. The "Optional Practical Training" program allows foreigners on student visas to work for twelve months after earning their degrees, but those with STEM degrees can earn a seventeen-month extension. The list of eligible degrees includes urban forestry, air conditioning technician, and animal health; list available on the Immigration and Customs Enforcement website, www.ice.gov/doclib/sevis/pdf/stem-list.pdf.

78. Steve Case, "As Congress Dawdles, the World Steals Our Talent," *Wall Street Journal*, September 9, 2013, http://online.wsj.com/news/articles/SB10001424127887324577304579054824075952330 (subscription required).

79. The March for Innovation, www.marchforinnovation.com.

80. See the Information Deficit website: http://www.innovationdeficit.org/facts.

81. Gabrielle Karol, "Immigration Reform Group Launches 'Job Loss' Clock," FoxBusiness.com, http://smallbusiness.foxbusiness.com/legal-hr/2014/03/19/immigration-reform-group-launches-job-loss-clock.

82. For an insightful critique of this approach, see Sarewitz, *Frontiers of Illusion*, chap. 2.