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Chapter 6

Sputnik Moments

Science and Technology Policy from Eisenhower to Obama

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On January 25, 2011, amidst a severe economic recession at home and myriad international challenges abroad, especially the economic rise of China and India, President Barack Obama delivered his State of the Union Address before a joint session of Congress and the American people. In it, he proposed that a key to solving the various problems and "winning the future" is to get back into the future, by boosting national investment in science, technology, and education to a level "not seen since the height of the space race." Invoking the era that started with the Soviet launch of the world's first artificial satellite in 1957, the president declared, "This is our generation's Sputnik moment." The Unites States, he believed, needed to "invest in biomedical research, information technology, and especially clean energy technology, an investment that will strengthen our security, protect our planet, and create countless new jobs for our people."[1]

President Obama's invocation of the Sputnik moment invites comparison between his science, technology, and education policy and that of President Dwight D. Eisenhower, during whose second term in the White House the original Sputnik moment occurred. Indeed, Obama mentioned Eisenhower in more public speeches and statements during his first term in office alone than his Republican predecessor George W. Bush in two terms. Also, of all the presidents who came after Eisenhower, Obama has mentioned Sputnik in his speeches and statements more often than any other except for Lyndon B. Johnson, and frequently in conjunction with an invocation of Eisenhower's response to it.[2] So, was the Sputnik moment a good analogy for our time? In what ways did Eisenhower and Obama face similar challenges and in what ways did their situations differ in terms of both specific policy issues in science, technology, and education, and the broader domestic and international political environments?

THE ORIGINAL SPUTNIK MOMENT

On October 4, 1957, when the Soviet Union launched Sputnik, it touched off widespread concern in the United States, especially in the media and among politicians, that the nation had fallen behind its Cold War rival.[3] Yet, as often is the case, the meaning of a shocking event is rarely self-evident. What exactly Sputnik represented was not immediately clear. Everyone agreed that it marked a remarkable step in human exploration in space, but what more did it signify and what American response did it demand? Was it a military-technological defeat of the United States "worse than Pearl Harbor" that required a vast expansion of American nuclear weaponry, as Edward Teller, the politically conservative and influential nuclear physicist, claimed? Or was it an event that did not change the overall Western strategic strength over the Soviet camp, even as it warned about the need to improve American science and education broadly, as the more moderate scientists and commentators insisted?

About a month after Sputnik's launch, President Dwight Eisenhower went on national television and radio to speak on "Science in National Security," to address these Sputnik-inspired concerns and define the nature of the Sputnik crisis. He made it clear that Sputnik did not represent a military defeat for the United States—this nation and its Western allies were well ahead in overall military strength, especially in their multipronged nuclear weapons systems and worldwide military bases. But he did use the Sputnik shock to urge the country to pay more attention to and invest more in science and education, thus siding with moderate scientists' interpretation of the meaning of Sputnik. Indeed, perhaps the single most significant specific step he announced in his speech was the appointment of James Killian, president of the Massachusetts Institute of Technology and a leader of the moderate wing of the American scientific community, instead of someone like Teller, to fill the newly created position of the special assistant to the president for science and technology (science advisor).[4] Soon Eisenhower and Killian would together reconstitute the Science Advisory Committee of the Office of Defense Mobilization (ODM-SAC) in the Executive Office of the President and upgrade it to the White House itself as the President's Science Advisory Committee (PSAC). The committee was chaired first by Killian and then by George Kistiakowsky, a Harvard chemistry professor who succeeded Killian as Eisenhower's science advisor in 1959. The committee was also dominated by prominent and politically moderate and bipartisan scientists and engineers (at least half of whom were said to be Democrats) and would play a crucial role in science and technology in the remainder of the Eisenhower presidency.[5]

Yet, despite Eisenhower's public reassurance of the military strength of the Western alliance and his belief that Sputnik did not represent a military

threat, he knew that much of the alarm generated by Sputnik had to do with people's concern over the missile program ("missile gap") and that there was a real need to better coordinate the federal government's military technology program. Thus, when he announced Killian's appointment, he highlighted the latter's duty to ensure "that the entire program [of science, technology, and missiles] is carried forward in closely-integrated fashion" and that "our best talent and the full necessary resources are applied on certain high-priority top-secret items."[6] In his letter to Killian that served as the legal foundation for the new science advisor's office in the White House a month later, Eisenhower further made it clear that Killian's primary attention should be given to "the use of science and technology in relation to national security" and to "giving a greater sense of direction" to the development of American science and technology.[7]

The same emphasis on national security guided Eisenhower's early post-Sputnik thinking on the American space program. He worried that a runaway space program aiming at beating the Soviets in space "stunts" would harm both national security and the economy. Thus, contrary to common perceptions, he initially thought that the American space program should be made part of the Department of Defense. He famously resisted calls for the launchings of lunar probes by saying that "we [don't] have any enemy on the moon!" It was Killian and PSAC scientists who convinced Eisenhower that lodging the space program in the DOD would restrict and militarize space scientific research and hamper international collaboration. Eventually, he approved their recommendation that a new civilian space agency—NASA—be created by upgrading the existing National Advisory Committee on Aeronautics while leaving the Pentagon to continue its own military space programs.[8]

More broadly, Eisenhower, as a fiscal conservative who had been increasingly concerned about both the danger of nuclear war and the harmful influence of what he would later call the military-industrial complex, saw in the Sputnik crisis an opportunity to implement organizational reforms at the Pentagon and make moves in nuclear arms control. In addition to asking his new science advisors to help him curb inter-service rivalry, which he thought was in part responsible for the ballooning defense budget, he also approved the establishment of ARPA in the DOD to take over anti-missile and other contentious high-tech programs from the individual services. Later, ARPA was known, of course, for its role in sponsoring the early research that led to the Internet. More importantly, Eisenhower pushed through, with the support of PSAC, the 1958 Defense Reorganization Act which strengthened the authority of the secretary of defense at the expense of the services, established unified commands under the DOD instead of individual services, and created a new position of the director

of Defense Research and Engineering in the DOD—ranked just below the secretary and deputy secretary of defense—to centralize military research and development.[9]

Eisenhower also took advantage of the Sputnik shock to bring moderate scientists such as Killian and PSAC members into arms control. The president knew they were more sympathetic toward nuclear arms control, especially a nuclear test ban, than Teller and his supporters, who had been influential in the making of policy. Even though the negotiations toward a test ban under Eisenhower were tortuous and eventually faltered with the Soviet downing of the U-2 reconnaissance plane in 1960, they started the process of nuclear arms control in earnest during the Cold War. It would bear its first fruit in the 1963 Limited Nuclear Test Ban under John F. Kennedy. Perhaps equally important, it helped train and educate a generation of American scientists and diplomats on the intricacies of nuclear arms control negotiations in which science and technology often played an important role.[10]

It should be pointed out that in the history of post-World War II presidential science advising, Eisenhower, perhaps more than any other president, reshaped the thinking of his science advisors, with his emphasis on the imperative of arms control and the need to curb the expansion of the military-industrial complex. Among his science advisors and PSAC members, Killian, Kistiakowsky, Herbert York, and Jerome Wiesner all explicitly acknowledged the impact of Eisenhower in leading them to recognize the limits of military technology and the necessity to look at the big picture and the long run. As Kistiakowsky later reflected in a preface to his published diary:

> I joined PSAC and then assumed the office [of presidential adviser] seeing myself as a technician whose task it was to execute the general policies set by my superiors. . . . Conversations with the President, not all of which are here recorded, were especially influential in making me more of an independently thinking citizen, interested in the meaning and objectives of policies more than in their detailed execution.[11]

Even Wiesner, who served as an advisor to John Kennedy during the 1960 presidential election campaign while a member of Eisenhower's PSAC and who went on to become Kennedy's science advisor, came to espouse Eisenhower's view that the United States should achieve nuclear sufficiency, not superiority, during heated debates over a nuclear test ban within the Kennedy administration.[12]

Such use of science and science advising by Eisenhower and the federal government in policy areas such as space, defense, and arms control formed only the first half of what is commonly regarded as science policy. Sometimes called "science in policy," it dealt with how the government used science.

The other half had to do with the government's support of science, or "policy for science." In other words, if "science in policy" dealt with the question of "what can science do for the government," "policy for science" addressed the question of "what can government do for science." Sputnik made a difference in "science in policy," as it reinforced Eisenhower's conviction about the danger and absurdity of nuclear wars and gave him the opportunity to pick a group of moderate scientists to serve on PSAC. They advocated arms control and helped him rationalize the space and defense programs. What differences, then, did Sputnik make in the area of "policy for science"?

Most crucially, Sputnik reinforced the importance of science to national security that had been first demonstrated by the use of the atomic bomb at the end of World War II. This new appreciation of science for security was indicated, among other things, by the title of the first of Eisenhower's post-Sputnik speeches—"Science in National Security." Here, it should be noted that Sputnik was more an achievement in technology than science, but as the historian Paul Forman has argued, most people subordinated technology to science and considered it "applied science" in this period of modernity.[13] Thus, Sputnik allowed moderate scientists such as those in the ODM-SAC and PSAC to make the case for interpreting Sputnik as a challenge to American science and science education and for advocating increasing federal support in those areas. In practice, however, growth in federal support for research and development reached far beyond science or basic research but also, much more substantially, in applied research and development, especially in areas related to defense and space.

Second, Sputnik highlighted a new justification for federal support of science: national prestige. Quite apart from its military implications, the Soviet space achievement stirred in the minds of many Americans an affront to national pride, thus giving rise to a powerful argument that the federal government had to support what might appear to be impractical scientific research if it had the potential to enhance the international prestige of the United States in the world.[14] This rationale became a potent addition to national security in justifying federal support of such Big Science fields as high energy physics. For example, Eisenhower's science advisors invoked national prestige in their (eventually successful) advocacy of federal funding of the two-mile-long, $100 million Stanford linear electron accelerator.[15] Sputnik-inspired attention to national prestige also helped drive the founding of NASA, which in turn supported a large array of basic and applied research.

As a political and fiscal conservative, Eisenhower naturally reacted to these trends toward increased federal spending on science, technology, and education with alarm. In addition to his desire for a balanced budget and limiting the scope of the federal government, the president also grew concerned about

the influence of the military-industrial complex, which inevitably received a post-Sputnik big push despite his attempt to interpret the Soviet space feat as not a military threat. He had long held a somewhat idealistic view of science as the pursuit of truth that could be best carried out without governmental intrusion, and as a force for world peace that should not be dominated by the military. Presenting the Atoms for Peace award to the Danish physicist Niels Bohr shortly after the launch of Sputnik, Eisenhower remarked

> In these days when science is so obviously an essential source of national security and material welfare, it is well to remember that it is more than that. Scientific research is a great adventure of the human mind. . . . The whole world can gain through support and respect for basic research, for education and for learning.[16]

But interactions with the moderate scientists as represented by PSAC gradually convinced Eisenhower that the federal government indeed had a role to play in supporting basic research and science education, even as they worked together to rationalize and curb the expansion of technological programs. Here, as in the case of his change of mind on the question of military versus civilian control of the space program, Eisenhower exhibited a non-ideological, non-dogmatic pragmatism. As he told PSAC scientists in 1960, "Gentlemen, I think you have convinced me . . . I am convinced that basic research is a federal responsibility."[17]

PSAC scientists helped persuade Eisenhower to accept federal support of science with the articulation of what I call a philosophy of "technological skepticism." It recognized the limits of technological fixes in solving social and political problems. This skeptical perspective also appreciated the value of basic research in the evaluation of technological programs and as a means to temper blind technological enthusiasm. In this understanding, PSAC's advocacy and Eisenhower's acceptance of federal support of basic research were not in contradiction but were rather in keeping with their concern over the influence of the military-industrial complex: they hoped that federal support of basic research would not only provide a vital resource in moderating the military-technological momentum of the Cold War arms race but also preserve, idealistically, a precious counter-militaristic domain.

This view of basic research as a possible antidote to the military-industrial complex was clearly expressed in Eisenhower's explanation to Kistiakowsky of his less famous and often misunderstood second warning in his farewell speech—the "danger that public policy could itself become the captive of a scientific-technological elite." Many people then and later thought that Eisenhower "was turning against science" and against his own science advisors. But that was not what Eisenhower had in mind. Kistiakowsky recorded their conversation when he told the president of such reactions:

> The President expressed extreme concern that his remarks could have been misunderstood. He said that he made an especial effort in wording his speech to make clear the connection of what he called the scientific-technological elite with the military-armament industry complex and to distinguish it from the true scientific research to which he paid tribute. He spoke of his concern and foreboding on seeing hundreds of pages of ads tying "science" to armament, assuring the people that research meant better missiles, etc. He said that even the educational institutions, whose task it is to support free intellectual inquiry and the acquisition of new knowledge, were in the competition for big money military R&D contracts and were influencing research people on their staff to abandon basic research for the sake of higher monetary awards. . . . [A]s I listened to him I found an extraordinary degree of similarity between his convictions and the remarks on the same subject which I heard from most of you at many meetings of our Committee.[18]

Thus, to both Eisenhower and PSAC, federal support of basic research, especially by civilian agencies such as the National Science Foundation and the National Institutes of Health, was a matter not only of "policy for science" but also of "science in policy." They wanted to ensure that there was a place for basic research in the evaluation of technology. Indeed, in his memoir Eisenhower listed "[making] certain that the government was supporting both basic and applied research" as one of the accomplishments of his science advisors.[19]

OBAMA'S SPUTNIK MOMENT

More than a half century after the launch of Sputnik, Eisenhower's low-key handling of its challenge has received largely positive evaluations by historians and other scholars, though some have criticized him for a lack of public leadership that may have, ironically, fueled the military-industrial complex that he saw as problematic.[20] Federal support of R&D did rise dramatically for about a decade, making it a golden age of American science, technology, and education. Eisenhower's post-Sputnik years have also been remembered for the scientific and technological institutions established, most prominently NASA and ARPA, which have been viewed as symbols of American innovation.

What made it possible for the nation to make the necessary investment and establish needed institutions in science and technology during the post-Sputnik era was a political system anchored by what historians have called a "Cold War liberal consensus." Shared by moderates in both the Republican and Democratic parties, this consensus view recognized the need to combat Communism abroad and to solve social problems such as poverty

and racism at home through incremental political reforms and technology-driven economic growth. Despite partisan differences on specific issues and moral concerns as expressed by Eisenhower in his farewell speech, in general American science, technology, and education policies in the late 1950s and early 1960s were made based on their serving the country's national security and the waging of the Cold War in all its many facets.

It is perhaps no wonder that Barack Obama fondly invoked the Sputnik era, not only for its technological innovations but also for the image of a greater national political unity. Like Eisenhower with Sputnik, Obama tried to define the challenges from the rise of countries such as China and India not as primarily military but as ones in science, technology, and education, and proposed corresponding responses in those areas, especially in clean energy.[21] During a campaign speech in June 2008, for example, candidate Obama drew an analogy between Sputnik and the energy problem facing the nation:

> In the past, America has been stirred to action when a new challenge threatened our national security. That was true when German and Japanese armies advanced across Europe and Asia, or when the Soviets launched Sputnik. The energy threat we face today may be less direct, but it is real. Our dependence on foreign oil strains family budgets and saps our economy. Oil money pays for the bombs going off from Baghdad to Beirut, and the bombast of dictators from Caracas to Tehran. Our nation will not be secure unless we take that leverage away, and our planet will not be safe unless we move decisively toward a clean energy future.[22]

Once elected, he repeatedly invoked Eisenhower (and Lincoln and FDR) as leaders who believed that "[t]here are some things we can only do together as a nation."[23] He lifted the spirit of the scientific community with the appointments of respected scientists in his administration, including John Holdren, an advocate on global warming, as his science advisor, provided unprecedented federal support of basic research through a stimulus package, and endorsed scientific integrity in administration policy making. He also made clean energy one of his central science and technology policies and often used the Sputnik analogy to promote it as he did in his 2011 State of the Union Address. He appointed Steven Chu, a Nobel laureate physicist and advocate of clean energy, to head the Department of Energy which established ARPA-E to do for energy R&D what ARPA did in defense and information technology.[24]

Yet the Cold War liberal consensus that undergirded Eisenhower's response to Sputnik, with its priority on waging the Cold War and its complacency about domestic problems, has been long gone, having received fatal blows in the late 1960s with the anti-Vietnam War and civil rights movements, and

then with the end of the Cold War itself in the early 1990s. Thus, in contrast to Eisenhower, Obama has faced a much more polarized and partisan political environment during his term in office, which intensified the long-running debate over federal support of science, technology, and education. Republican law makers, for example, questioned the Obama administration's support of solar technologies as meddling in the market place, especially after Solyndra, one such firm so supported, was forced to declare bankruptcy in 2011 in the face of fierce international competition.[25] Some GOP leaders also tried to stop Obama administration officials from engaging in international scientific contact and exchange with countries such as China.[26] Obama's signature legislative achievement, the Affordable Care Act, had to be passed with no Republican support.[27]

There were other changes from Eisenhower to Obama that affected science and technology policy. In the Eisenhower years, a key part of American national security—nuclear weapons, including both warheads and delivery systems—was in its formative stage. Development depended on cutting-edge science and technology and required the active involvement of many prominent scientists and engineers. Today, nuclear weapons are a relatively mature technological system and do not command the priority in science and technology policy that they did then. The military still claims a large part of federal R&D spending, especially in the areas of cybersecurity and anti-terrorism technologies, but there is no longer the perception of a tight connection between science and security that existed in Eisenhower's Sputnik moment. Instead, energy, environment, education, and health have taken center stage in current science and technology policy debates, which tended to be politically more divisive than those over defense.

Without the focusing lens of an existential struggle that was the Cold War, the debates over science and technology policy under Obama have been more defused than that during the Eisenhower years. President Obama recognized this reality when he talked about the energy challenge at the National Academy of Sciences in April 2009:

> There will be no single Sputnik moment for this generation's challenges to break our dependence on fossil fuels. In many ways, this makes the challenge even tougher to solve, and makes it all the more important to keep our eyes fixed on the work ahead. But energy is our great project—this generation's great project.[28]

In this area, Obama, like Eisenhower, exhibited pragmatism in his support of expansion of all forms of domestic energy, in both traditional forms such as natural gas and nuclear power, as well as the more desirable alternative and clean energy technologies such as solar and wind. By the end of his first

term, the verdict on Obama's great energy project was a mixed success. The United States had expanded its domestic energy supplies, especially natural gas, which is cleaner than coal, to a point where it was projected to achieve energy independence within several years. Clean energy research, development, regulations, and utilization have grown, but enactment of laws aimed to combat global climate change stalled, largely due to bipartisan opposition in Congress, from not only conservative Republicans but also some Democrats from coal-producing states.[29] In his second inaugural speech on January 21, 2013, President Obama made climate change and clean energy policies a central theme for his second term, announcing that "we will respond to the threat of climate change, knowing that failure to do so would betray our children and future generations." He called on the United States to lead the transition to sustainable energy sources in the world. How successful this effort will be remains to be seen, even following the landmark agreement he reached with the Chinese government in Beijing in November 2014 for future reductions in greenhouse gas emissions.[30]

Finally, globalization has changed the international ecology for American science and technology policy from the Eisenhower years. This was made clear in a 2012 report by the President's Council of Advisors on Science and Technology (PCAST), a successor to PSAC that was first established by President George H. W. Bush. In contrast to about 50 percent of the world's GDP in the 1950s, PCAST pointed out, the United States in the 2010s accounted for less than 25 percent. When the United States was the dominant economy in the world, it was in its national interest to encourage advances in basic research everywhere so its advanced technological system could take advantage of them. Now the nation still takes such advantages, but other countries can also increasingly do so. Furthermore, while the massive migration of scientists and engineers to the United States, which in many ways accelerated in the Eisenhower years, has contributed to American scientific and technological leadership in the world, the continuing ties of international students and immigrant scientists to their home countries also help "further global leveling of the scientific playing field."[31]

Obama's PCAST argued that the complex reality of international science and technology does not mean that the United States should reduce its investment in basic research, but that it should act to ensure that all nations support and benefit from basic research. Otherwise, it warned, there will be the tragedy of the commons—"a zero-sum world in which no country invests in the long-term basic research for the future, while all scramble to compete over the diminishing returns from past investments."[32] PCAST defined basic research not as the source of specific applications but as something that "fuels a whole innovation ecosystem, often in unpredictable ways." Echoing PSAC's arguments, PCAST saw research universities as "hubs" of that

innovation ecosystem and argued that the U.S. government must continue to serve as the only "patient investor" for basic research.[33]

In conclusion, this comparative examination of Dwight Eisenhower's and Barack Obama's science and technology policy indicates that indeed the two presidents shared remarkably similar policy preferences—for pragmatic actions by the government, for basic research, for balance, and for long-term solutions—but their external political environments, both domestic and international, were very different. The prominence of national security and national prestige in science and technology policy in the post-Sputnik era has given way to priorities related to economy, energy, environment, and international competition in technological innovations, while a more intense political partisanship has made it hard to reach policy consensus. While both presidents succeeded, to a certain degree, in defining and capitalizing on their respective crises—Sputnik then and the rise of China and India now—to promote science, technology, and education, the significance of Obama's science and technology policy still depends on what happens in his second term and beyond.

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NOTES

1. Barack Obama, "Address before a Joint Session of the Congress on the State of the Union," January 25, 2011, http://www.presidency.ucsb.edu/ws/index.php?pid=88928, accessed in December 2012.

2. The searches and counting were done with the "Public Papers of the Presidents" database at http://www.presidency.ucsb.edu/ws/index.php, accessed in January 2013. Obama mentioned Eisenhower 130 times from 2009 to 2012 vs. Bush's 71 times from 2001 to 2009. Most of Obama's references to Eisenhower had to do with the latter's leadership in the construction of the interstate highway system (about 70 times), low federal discretionary spending as a share of the economy during the Eisenhower years, and Eisenhower's responses to Sputnik in the areas of science, technology, and education.

3. On the political reactions to Sputnik, see Yanek Mieczkowski, *Eisenhower's Sputnik Moment: The Race for Space and World Prestige* (Ithaca, NY: Cornell University Press, 2013).

4. Dwight D. Eisenhower, "Radio and Television Address to the American People on Science in National Security," November 7, 1957, http://www.presidency.ucsb.edu/ws/index.php?pid=10946, accessed in January 2013.

5. On PSAC, see Zuoyue Wang, *In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America* (New Brunswick, NJ: Rutgers University Press, 2008).

6. Eisenhower, "Radio and Television Address," November 7, 1957.

7. Eisenhower to Killian, December 7, 1957, reprinted in James Killian, *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge, MA: MIT Press, 1977), 35–36.

8. Wang, *In Sputnik's Shadow*, 91–97.

9. Wang, *In Sputnik's Shadow*, 102–5.

10. Wang, *In Sputnik's Shadow*, 120–41. See also Benjamin Greene, *Eisenhower, Science Advice, and the Nuclear Test Ban Debate, 1945–1963* (Stanford, CA: Stanford University Press, 2006).

11. George Kistiakowsky, *A Scientist at the White House: The Private Diary of President Eisenhower's Special Assistant for Science and Technology* (Cambridge, MA: Harvard University Press, 1976), ix. See also Wang, *In Sputnik's Shadow*, 109.

12. Wang, *In Sputnik's Shadow*, 226.

13. Paul Forman, "The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology," *History and Technology* 23 (March/June 2007): 1–152.

14. For a nuanced discussion of the rising importance of national prestige, see Mieczkowski, *Eisenhower's Sputnik Moment*.

15. Wang, *In Sputnik's Shadow*, 142–57.

16. Eisenhower, "Remarks at the Presentation to Professor Niels Henrik David Bohr of the First Atoms for Peace Award," October 24, 1957, available at http://www.presidency.ucsb.edu/ws/index.php?pid=10940, accessed in January 2013.

17. Wang, *In Sputnik's Shadow*, 171.

18. George Kistiakowsky to PSAC members, January 19, 1961, as reprinted in Wang, *In Sputnik's Shadow*, 175.

19. Dwight D. Eisenhower, *Waging Peace: 1956–1961* (Garden City, NY: Doubleday, 1965), 224.

20. See, e.g., Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993); Matthew Brzezinski, *Red Moon Rising: Sputnik and the Hidden Rivalries that Ignited the Space Age* (New York: Times Books, 2007); Mieczkowski, *Eisenhower's Sputnik Moment*.

21. On this point see Zuoyue Wang, "China, Sputnik, and American Science," *APS [American Physical Society] News*, November 2011, available at http://www.aps.org/publications/apsnews/201111/international.cfm, accessed in January 2013.

22. Barack Obama, "Remarks at Kettering University in Flint, Michigan," June 16, 2008, available at http://www.presidency.ucsb.edu/ws/index.php?pid=77478, accessed in January 2013.

23. See, for example, Obama, "Remarks at a Democratic National Committee Fundraiser in New York City," September 20, 2011, available at http://www.presidency.ucsb.edu/ws/index.php?pid=96786, accessed in January 2013.

24. See, for example, Obama, "Remarks at the National Academy of Sciences," April 27, 2009, available at http://www.presidency.ucsb.edu/ws/index.php?pid=86059, accessed in January 2013. Caral Davenport, "The Education of Steven Chu," *National Journal*, January 17, 2013, available from http://www.nationaljournal.com/white-house/the-education-of-steven-chu-20130117, accessed in January 2013.

25. See, for example, Matthew L. Wald, "Republican Attack on Handling of Stimulus Money and Green Jobs," *New York Times*, September 22, 2011, available from http://www.nytimes.com/2011/09/23/science/earth/23energy.html?ref=solyndra, accessed in January 2013.

26. Charlie Savage, "Meeting with Chinese, Official Tests Limits Set by Congress," *New York Times*, November 3, 2011, available from http://www.nytimes.com/2011/11/03/us/politics/meeting-with-chinese-official-tests-limits-set-by-congress.html, accessed in January 2013.

27. See, for example, Robert Pear and David M. Herszenhorn, "Obama Hails Vote on Health Care as Answering 'the Call of History'," *New York Times*, March 22, 2010, available from http://www.nytimes.com/2010/03/22/health/policy/22health.html?pagewanted=all, accessed in January 2013. See also Wang, "China, Sputnik, and American Science."

28. Obama, "Remarks at the National Academy of Sciences," April 27, 2009, http://www.presidency.ucsb.edu/ws/index.php?pid=86059, accessed in December 2012.

29. See, for example, *Hot Politics*, a PBS Frontline documentary first aired in 2007, available from http://www.pbs.org/wgbh/pages/frontline/hotpolitics/, accessed in December 2013; and John M. Broder, "Climate Bill Is Threatened by Senators," *New York Times*, August 7, 2009, A12.

30. Obama, "Inaugural Address," January 21, 2013, available from http://www.presidency.ucsb.edu/ws/index.php?pid=102827, accessed in January 2013. See also Richard W. Stevenson and John M. Broder, "Speech Gives Climate Goals Center Stage," *New York Times*, January 22, 2013, available from http://www.nytimes.com/2013/01/22/us/politics/climate-change-prominent-in-obamas-inaugural-address.html?ref=todayspaper, accessed in January 2013. Mark Landler, "U.S. and China Reach Climate Accord after Months of Talks," *New York Times*, November 11, 2014, available from http://www.nytimes.com/2014/11/12/world/asia/china-us-xi-obama-apec.html, accessed in April 2015.

31. PCAST, "Transformation and Opportunity: The Future of the U.S. Research Enterprise," November 2012, available from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_future_research_enterprise_20121130.pdf, accessed in January 2013. On the migration of several thousands of Chinese scientists and engineers to the United States in the 1950s, see Zuoyue Wang, "Transnational Science during the Cold War: The Case of Chinese/American Scientists," *Isis* 101 (June 2010): 367–77, available from http://www.jstor.org/stable/10.1086/653098, accessed in January 2013, and Benjamin Zulueta, "Forging the Model Minority: Chinese Immigrant Intellectuals, American Science, and the Cold War" (Ph.D. diss., Univ. of California, Santa Barbara, 2003).

32. PCAST, "Transformation and Opportunity," 1.

33. PCAST, "Transformation and Opportunity," 4, 7, 25.