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The Fall of Vannevar Bush: The Forgotten War for Control of Science Policy in Postwar America

ABSTRACT

Vannevar Bush was at the forefront of American research policy during World War II, but he suffered a steep fall after the war, and by 1948 had left government service altogether. What motivated such a significant loss of influence? Drawing on previously unexamined sources, this article traces the causes of Bush's decline in authority to his loss of powerful allies, particularly with the death of Franklin Roosevelt and the retirement of Henry Stimson; to his long-standing feuds with military leaders; and to several political missteps on Bush's part that alienated figures in Congress and elsewhere. Continued examples of personal conflict in the postwar period not only impacted Bush's career, but also shaped the structure of the resulting institutions that emerged to fund Cold War–era science. Rather than an abrupt change occurring immediately after the war, the postwar transition to public institutions was both gradual and influenced by the personal networks that preceded it. Bush's quiet departure from government was tied to the emergence of military dominance in American research, largely at the expense of civilian scientific leaders. Such a shift in control of research policy had

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The following abbreviations are used: BBS, Bush Book Senior, *Pieces of the Action*; FDR, Franklin Delano Roosevelt; *HSPS*, both *Historical Studies in the Physical and Biological Sciences* and *Historical Studies in the Natural Sciences*; HSTL, Harry S Truman Library; JRDB, Joint Research and Development Board; LOC, Library of Congress; MC, Manuscript Collection; MIT, Massachusetts Institute of Technology; NARA, National Archives and Records Administration; NASA, National Aeronautics and Space Administration; NDRC, National Defense Research Committee; NSF, National Science Foundation; *NYT, New York Times*; OHI, Oral History Interview; ONR, Office of Naval Research; OSRD, Office of Scientific Research and Development; R&D, Research and Development; RG, Record Group; VB MSS, Vannevar Bush Manuscripts.

a dramatic effect on resulting postwar initiatives, closely connecting scientific advancements to national security.

INTRODUCTION

Among the many figures who guided American science and technology in the twentieth century, few possessed the impact or capabilities of Vannevar Bush. Working in the highest levels of government, Bush used his skill as a scientific administrator to turn wartime America into a technological superpower. After joining the top echelon of officials in the Roosevelt administration, Bush proceeded to establish one of the foremost research agencies in history.[1] That agency, the Office of Scientific Research and Development (OSRD), provided funding for the most cutting-edge programs of the era, including the Manhattan Project and radar. Key to these advancements was Bush's view of technology as a product of basic research, motivating the OSRD to fund both pure and applied fields.[2] Under Bush's leadership, the OSRD directly employed almost six thousand American scientists, spread across three hundred universities.[3] James Bryant Conant, the chemist and president of Harvard University, worked closely with Bush throughout the war and held him in very high regard. Conant later wrote that "the reader who understands anything of the ways of men will agree with me when I say that the United States was indeed lucky that such an extraordinary man had President Roosevelt's ear."[4] So crucial were Bush's contributions to the Allied victory, whether in the development of the proximity fuse or fission bomb, that the military's prewar opinion of research being a separate endeavor from strategy and tactics was

1. The founding of the OSRD is recounted in Irvin Stewart, *Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development* (Boston: Little, Brown, 1948), esp. 35–40; Larry Owens, "The Counterproductive Management of Science in the Second World War: Vannevar Bush and the Office of Scientific Research and Development," *The Business History Review* 68, no. 4 (1994): 515–76.

2. Ronald Kline, "Construing 'Technology' as 'Applied Science': Public Rhetoric of Scientists and Engineers in the United States, 1880–1945," *Isis* 86, no. 2 (1995): 194–221, on 218.

3. Pamphlet "Secret Army," 1944, MIT Archives VB MSS, MC-0078, Box 22, Folder "OSRD and World War II."

4. Chapter 10a, "Once Again a Chemist in National Service," 1969, MIT Archives VB MSS, MC-0078, Box 3, Folder "Notes on Dr. Conant's Book by V. Bush, 1969."

replaced by a zealous desire to lead it.[5] Bush set the paradigm for American science during his administration of the OSRD, a role that disappeared in the postwar.

In addition to his direct leadership of American research, Bush's wartime contributions also included recruiting other scientific leaders into government service. Bush's wartime success confirmed the relatively new role of federal government-sponsored research, revealing the importance of scientific involvement in Washington.[6] Imagining a world in which civilian administrators like himself directed American science policy, Bush appointed scientists including Arthur Compton, James Conant, and Frank Jewett to high positions in the OSRD.[7] As the chief policymaker of American science during a war dominated by technological advancement, Vannevar Bush's wartime position was so significant that he was christened the "General of Physics" in his 1944 feature on the cover of *Time* magazine.[8]

As the prospect of Allied victory in World War II became apparent in 1945, Bush began to develop blueprints for a vast postwar research establishment. He possessed a grand vision for the technical world, with Secretary of War Henry L. Stimson writing in February 1945 that "Bush came in to talk with me about postwar scientific problems [proposing] a general pooling among nations of all scientific research."[9] Bush began preparation of the groundbreaking report *Science: The Endless Frontier*, marking the first step toward what would become

5. A sampling of the literature regarding the military's transition to strong advocacy of research includes Thomas Lassman, *Sources of Weapon Systems Innovation in the Department of Defense: The Role of In-House Research and Development, 1945–2000* (Washington, DC: United States Army Center of Military History, 2008); David K. Allison, "U.S. Navy Research and Development since World War II," in *Military Enterprise and Technological Change: Perspectives on the American Experience*, ed. Merritt Roe Smith (Cambridge, MA: MIT Press, 1985), 289–328, esp. 295; Stuart Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993), esp. 7–8; Harvey Sapolsky, *Science and the Navy: The History of the Office of Naval Research* (Princeton, NJ: Princeton University Press, 1990), 20–33.

6. G. Pascal Zachary, *Endless Frontier: Vannevar Bush, Engineer of the American Century* (New York: The Free Press, 1997), 118–24.

7. Ibid.; Chapter 10a, 1969, MIT Archives VB MSS (ref. 4).

8. Michal Meyer, "The Rise and Fall of Vannevar Bush," *Distillations*, 21 Jul 2018, https://www.sciencehistory.org/distillations/the-rise-and-fall-of-vannevar-bush (accessed Jul 2021); Ernest Baker, Dr. Vannevar Bush, 3 Apr 1944, *Time* cover photograph, http://content.time.com/time/covers/0,16641,19440403,00.html (accessed Jul 2021).

9. Henry Stimson's Personal Diary and Papers, 15 Feb 1945, Henry Lewis Stimson Papers, Reel 9, Yale University Library.

the National Science Foundation.[10] In envisioning this new world of scientific advancement, Vannevar Bush saw a system with similar leaders to those of the wartime years, namely one dominated by civilians including himself.[11] The well-known concept of "basic science" research, which altered the view on how to maximize scientific and technological progress, was pioneered by Bush during his efforts to enshrine *Science: The Endless Frontier* into law.[12] Bush even vied for appointment as Secretary of Defense after the position's creation in the 1947 National Security Act, especially after he was named as a legitimate candidate by the *New York Times*.[13] The postwar future seemed promising to Bush, who in a memorandum to the OSRD praised his war-weary scientists, promising to lead them in "genuinely building the strength which this nation must have if it is to lead the way toward permanent peace."[14] Expecting strong cooperation between the government and his civilian researchers, and teeming with ideas for postwar policy, Bush was likely assuming that the success he experienced in wartime would continue unabated.

Despite his optimism, this Vannevar Bush–led future of American science would never be realized. Within three years of the Allied victory, Bush would be ousted from the circles of influence that dominated the nascent Truman administration, retiring from full-time government service in 1948.[15] His final position in the government, as chairman of the Defense Department Research and Development Board, was a role that he bitterly acknowledged was "mostly shadow boxing."[16] Bush retired completely from the nation's capital in 1955, leaving the Carnegie Institution of Washington to return home to Massachusetts.[17] Individuals like John Steelman, Lloyd Berkner, and William Golden

10. Zachary, *Endless Frontier* (ref. 6), 221–25.

11. Allan Needell, *Science, Cold War and the American State: Lloyd V. Berkner and the Balance of Professional Ideas* (New York: Routledge, 2012), 102.

12. Vannevar Bush, *Pieces of the Action* (New York: William Morrow, 1970), 65. Although the term "basic science" was likely coined by Bush in the 1940s, the history of the term and its use by Arthur Kennelly is recounted in Kline, "Construing 'Technology'" (ref. 2), 216–17.

13. Anthony Leviero, "Patterson Reported Quitting, Forrestal Due to Rule Arms," *NYT*, 16 Jul 1947; Edward Bowles, Office Diary, 23 Jun 1947, Bowles Papers LOC, Box 38; Zachary, *Endless Frontier* (ref. 6), 321–23.

14. Vannevar Bush, memorandum, 1946, Bush Papers, Tufts Archives, MS 169, Box 1. Although the exact date of Bush's memo is not listed, it was written in response to an April 27, 1946, memorandum by Eisenhower, found in Seymour Melman, *Pentagon Capitalism: The Political Economy of War* (New York: McGraw-Hill, 1970), 231–34.

15. Reel 6-A OHI, MIT Archives VB MSS, MC-0143, Box 1.

16. Reel 13-B OHI, MIT Archives VB MSS, MC-0143, Box 2.

17. Zachary, *Endless Frontier* (ref. 6), 380–81.

were among the many needed to fill the roles previously held in wartime by this once towering figure of American science.[18] Bush's control of the research establishment had ended quickly and with no apparent cause.

When examining American science policy during and after World War II, historians of science often note a significant shift. The war had seen decision-making made by a handful of elite individuals, including Bush, who used personal networks to direct hastily constructed organizations with mostly emergency powers. The postwar period, however, saw the establishment of permanent, federal institutions to conduct policy, in the place of personal networks. Most studies of the period make note of this shift in policy and characterize it as a rather abrupt change that occurred shortly after the start of the Truman administration.[19] In his case studies on the American research scene in the early postwar period, Nathan Reingold argues such a change had occurred as early as 1946, noting "a shift of support and control nationally, largely from a private frame of reference to a public, federal one."[20] This description of a sudden transformation is echoed by Jeffrey Stine and Gregory Good, who discuss a "post-World War II revolution" of federal funding for the sciences, specifically in the lens of instrumentation.[21]

Although this crucial turning-point in science policy was indeed a product of wartime events, the American research establishment did not become public and federal overnight. This study contributes to the argument that such a transition occurred, but develops it as a more gradual change. I argue that the undeniable shift in control from personal networks to public settings took place throughout Bush's fall from power, and examine the continued importance of personal relationships in science policy until Bush's departure from Washington in 1955. The more gradual decline of such a mode of policymaking accounts for many of the confounding features of the postwar period,

18. Needell, *Science, Cold War* (ref. 11), 4; Dennis Overbye, "William T. Golden, Financier and Key Science Adviser, Is Dead at 97," *NYT*, 9 Oct 2007.

19. Nathan Reingold, "Choosing the Future: The U.S. Research Community, 1944–1946," *HSPS* 25, no. 2 (1995): 301–28, on 301–02; Jeffrey Stine and Gregory Good, "Government Funding of Scientific Instrumentation: A Review of U.S. Policy Debates Since World War II," *Science, Technology, & Human Values* 11, no. 3 (1986): 34–46, esp. 35; Daniel Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942–1945: A Political Interpretation of Science—The Endless Frontier," *Isis* 68, no. 1 (1977): 4–26; Daniel Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944–46," *Technology and Culture* 16, no. 1 (1975): 20–47.

20. Reingold, "Choosing the Future" (ref. 19), 302.

21. Stine and Good, "Government Funding of Instrumentation" (ref. 19), 34.

including the creation of the Office of Naval Research and the protracted struggle over establishing the National Science Foundation. Further, the continued importance of personal networks had a discernible impact on the eventual makeup of the formal institutions that followed. Nowhere is the continued importance of personal relations seen better than in the fall of Vannevar Bush from power, which had profound effects on the direction of postwar science policy. In making this argument, I follow an interpretation of the NSF resolution similar to that espoused by historians including Jessica Wang and Reingold, namely that the 1950 legislation creating the NSF was far enough from Bush's original vision to be viewed as a defeat.[22]

Bush's role in World War II is documented extensively, yet comparatively scant emphasis is placed on his rapid loss of influence in the postwar period. His fall from grace was a quiet one—unlike his colleague J. Robert Oppenheimer, who was similarly pushed out of American science, no secret hearings were released that shattered Bush's public image. His loyalty was never questioned, and he never experienced a political scandal. Yet Bush shared a similar fate as Oppenheimer, departing from an unfriendly world he had once led and spending the remainder of his life far from the federal government.[23] This essay seeks to understand that fall, how it fit into the larger picture of postwar science policy, and what has been misunderstood about the last days in the government career of this prominent American figure.

Vannevar Bush's fall from power is a complex story, involving a loss of confidence in him by the various postwar factions that warred over control of the new research establishment. After President Roosevelt's death and Secretary of War Henry Stimson's retirement, Bush's political situation became threatened because of his lack of allies in the highest levels of government. This gave rise to an environment in which even the slightest mistakes had immense ramifications for Bush. The military was increasingly in conflict with him, expressing disdain for his actions both during and after World War II. Military leaders acted, often successfully, to curb his influence over postwar scientific research, and isolated him from the military-led organizations that

22. Bush's report is described to be, among other things, "more honored than heeded" in Nathan Reingold, "Vannevar Bush's New Deal for Research: Or the Triumph of the Old Order," *HSPS* 17, no. 2 (1987): 299–344, on 344. See also Jessica Wang, "Liberals, the Progressive Left, and the Political Economy of Postwar American Science: The National Science Foundation Debate Revisited," *HSPS* 26, no. 1 (1995): 139–66, on 147.

23. Kai Bird and Martin J. Sherwin, *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer* (New York: Alfred A. Knopf, 2005), 566–69.

emerged to provide funding to universities. Finally, Bush made several political blunders in the postwar period, particularly his attempted closure of the OSRD and missteps during the founding of the NSF. The resulting conflicts alienated him from many scientists and politicians, worsening his situation and hastening his departure from government. Personal relations recounted in this paper draw from a variety of sources, including the largely untapped archival drafts of Bush's memoir, *Pieces of the Action*, and G. Pascal Zachary's biography of Bush. While Zachary frequently establishes Bush's postwar fall as almost completely determined by "Bush's egotism and overbearing self-confidence,"[24] this paper adds texture to the personal disagreements encountered by Bush by placing them within the broader context of the geopolitical events that shaped the postwar period.

The postwar emergence of the military as a serious financial patron of research, especially in the physical sciences, has been a source of considerable discussion and debate among historians of science. Stuart Leslie, after analyzing Stanford University's successes under the postwar system, ended one study by questioning both the consequences and meaning behind "the game" of military patronage.[25] Such questions have been intensely debated, notably by Paul Forman and Daniel Kevles.[26] Forman argued that militarization led to a rather bleak outcome, writing that despite an "illusion of autonomy . . . physicists had lost control of their discipline."[27] In response, Kevles characterized such conclusions as value judgments on what constituted true science, arguing instead that militarization "was not the seduction of American physics from some true path but its increased integration as both a research and advisory enterprise into the national-security system."[28] Discussions regarding what constitutes research, the relationship between government and scientist, and how dominant the military's postwar research establishment was, cannot be separated from the fall of Vannevar Bush from political influence.

24. Zachary, *Endless Frontier* (ref. 6), 289–91, 323–44, 337.

25. Stuart Leslie, "Playing the Education Game to Win: The Military and Interdisciplinary Research at Stanford," *HSPS* 18, no. 1 (1987): 55–99, on 87–88.

26. Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960," *HSPS* 18, no. 1 (1987): 149–29; Daniel Kevles, "Cold War and Hot Physics: Science, Security, and the American State, 1945–56," *HSPS* 20, no. 2 (1990): 239–64.

27. Forman, "Behind Quantum Electronics" (ref. 26), 229.

28. Kevles, "Cold War and Hot Physics" (ref. 26), 264.

Additionally, such discussions are frequently accompanied by the assumption that the postwar rise of the military was an inevitable occurrence. Forman, quoting the historian Alex Roland, justified this claim by stating "national priorities . . . are the real issue. The nature of the research supported, and the level at which it is supported, follow the rationale and desiderata of American policy. Consequently, 'the military was bound to have a major voice in government patronage of science, no matter what institutional arrangements were adopted.'"[29] Although the prioritization of national security was surely a means to legitimize the postwar militarization of science, the prior years of civilian leadership of science amidst World War II suggest it was not the sole factor. The primacy of national security as a policy driver was stronger during World War II than in the postwar period, and yet did not yield military dominance of scientific governance. The fact that such a change is even present—that the Cold War militarization of science was a deviation from, rather than a continuation of, World War II science administration—begs a consideration of the factors that motivated such a fundamental shift in science policy.

Bush lost his influence rapidly, yet left with barely an uproar. Ironically, it had all been predicted in a telling letter Frank Jewett wrote to Bush in 1945, in which Jewett accurately summarized what would become of Bush:

> The whole thing is then likely to degenerate into a fight in which arrayed against your point of view are not only those who honestly disagree with you but likewise those who may not like you and the things you stand for.[30]

Ultimately, the swift yet quiet fall of Vannevar Bush from political power was motivated by a variety of factors and signaled a dramatic change in the governance of American research policy from civilian control to military dominance.

ROOSEVELT'S MAN

At the root of Vannevar Bush's wartime influence over American science was his remarkably personal friendship with the nation's president, Franklin

29. Alex Roland, "The Institutionalization of Science in the Military Establishment," 28 Dec 1984, in *National Security and the Post-War Science Establishment*, 99th American Historical Association Meeting, Chicago, quoted in Forman, "Behind Quantum Electronics" (ref. 26), 226.

30. Correspondence with Frank Jewett, Jun 1945, NARA, RG 227, OSRD Reports to President, quoted in Zachary, *Endless Frontier* (ref. 6), 253.

Delano Roosevelt. Among elite policymakers in American research, such a connection to the top levels of the federal government was indispensable. During World War II, the relationship Bush had with President Roosevelt allowed him to determine which technology would be pursued and who would direct it. Initially, Roosevelt and Bush did not appear to be natural allies. Bush was a political conservative, and a skeptic of the New Deal's economic reforms.[31] However, despite their differences in politics, both men shared the conviction that wartime technological supremacy largely depended upon governmental support for basic research. Bush and Roosevelt were in similar social and academic circles, both being connected to the influential Northeastern universities of America.[32] Their educational bond, coupled with their common vision of the importance of American science, provided the basis for a close friendship between Bush and the President that only a handful of Bush's colleagues, including James Conant, enjoyed.[33] For Bush, this friendship also provided a direct link to the most important politician in wartime America. Additionally, it established Bush as one of the only researchers involved in both politics and academia. Their relationship, initially formed in the prewar years, proved to be of tremendous benefit to Bush when the Second World War began.

As the president, Roosevelt provided Bush with assistance that unquestionably contributed to the success of Bush's wartime research programs. Roosevelt was well-connected among the American academic elite, but he was a man of very little technical background.[34] His lack of scientific expertise prompted Roosevelt to rely on his chief scientific advisor, Bush, with a high degree of trust. Although a president who believed himself to be well-versed in science might disagree with advice on which fields to ignore or encourage, Roosevelt often uncritically accepted Bush's point of view.[35] In one interview late in his life, Bush remarked that Roosevelt would take his advice "more or less on

31. Bush, *Pieces* (ref. 12), 67–68.

32. William Leuchtenburg, "Franklin D. Roosevelt: Life Before the Presidency," Miller Center; https://millercenter.org/president/fdroosevelt/life-before-the-presidency (accessed 13 Dec 2020); Zachary, *Endless Frontier* (ref. 6), 30–33.

33. James Hershberg, *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age* (New York: Alfred A. Knopf, 1993), 126–34. Conant was content as Bush's wartime deputy, rarely using the political leverage afforded by his friendship with FDR.

34. Leuchtenburg, "FDR: Life Before Presidency" (ref. 32).

35. NBC interview with V. Bush, 1965, MIT Archives VB MSS, MC-0078, Box 21, Folder "NBC White Paper. Decision to Drop the Atom Bomb, 1965," 466–68. This was an NBC White Paper interview with Bush on the decision to use nuclear weapons during the war.

faith."[36] This essentially gave Bush the opportunity to determine the President's opinion on various scientific questions, and therefore the entire nation's research policy. This was the reason why the United States rapidly developed fission research in the Uranium Committee and later the Manhattan Project, and employed a high degree of secrecy in scientific research with foreign nations, yet rarely focused on rocketry or increased funding for the humanities or social sciences.[37]

Roosevelt's tendency to automatically accept Bush's opinion on scientific matters was so well known that formal presidential approval was often not even required. The President rarely directly involved himself in scientific affairs and gave Bush great autonomy for independent action. Whereas Bush observed that Prime Minister Winston Churchill "butted in on all sorts of technical matters," Roosevelt's actions in wartime research appear to have been unusually laissez-faire. The President never told Bush what to do "in regard to any item," rarely expressing more than a casual interest in the progress made by the OSRD.[38] When Bush came to Roosevelt with a proposal, be it the creation of a government agency or a new policy on weapons research, it would usually be promptly christened with "OK—FDR," and Bush would then depart to carry out decisions in the President's name.[39] Even the famous request by the President that sparked *Science: The Endless Frontier* emerged from a casual comment by Bush that if proper measures were not taken, American postwar science would "fall flat on its face."[40]

By issuing such broad authorizations, Roosevelt enabled Bush to carry out his grand plan for wartime scientific development. Bush created a powerful, independent establishment for scientific research through the OSRD

36. Ibid., 467.

37. The Uranium Committee and fission research is recounted in Zachary, *Endless Frontier* (ref. 6), 190–92. For OSRD secrecy during the war, see Reel 4-B OHI, Section Title "Secrecy and Free Scientific Information Exchange," MIT Archives VB MSS, MC-0143, Box 1; Vannevar Bush, article "Churchill and the Scientists," 1962, MIT Archives VB MSS, MC-0078, Box 19, Folder "Churchill and the Scientists, 1962."

38. Reel 7-A OHI, MIT Archives VB MSS, MC-0143, Box 1. Churchill's actions regarding wartime science policy are recounted in Graham Farmelo, *Churchill's Bomb: How the United States Overtook Britain in the First Nuclear Arms Race* (New York: Basic Books, 2013), esp. 148–56.

39. Reel 7-B OHI, Section Title "Bush Appraises Characters," MIT Archives VB MSS, MC-0143, Box 1.

40. McElroy Interview with V. Bush, 15 Oct 1969, MIT Archives VB MSS, MC-0078, Box 24, 3–4. Other factors, which had been in play before this conversation, contributed to the Bush report, notably Oscar Cox and Harry Hopkins's concern over progressive legislation introduced by Harley Kilgore.

and its predecessor, the National Defense Research Committee.[41] Several scientific figures were brought into wartime governmental research by Bush, and later continued their new scientific-political careers.[42] The most prominent beneficiary from Roosevelt's leadership style, however, was Bush himself. The relationship he enjoyed with the President provided him with unparalleled independence to make decisions, as well as a personal association with the most powerful American statesman during World War II.

The importance of Roosevelt's friendship to Bush's success in wartime government cannot be overstated. That relationship is also why Bush's political position was significantly jeopardized by Roosevelt's death in April 1945. Not only did Bush lose a close friend, but also a president who championed his ideas and allowed him to operate with near-complete political freedom. Bush's fall from power after World War II began with the death of President Roosevelt, which deprived him of a vital ally.

The Secretary of War

With Vannevar Bush already suffering the loss of a presidential advocate with the death of Franklin Roosevelt, Bush's insecure political situation was significantly worsened by a similar occurrence in the Department of War. President Roosevelt was rightly regarded as Bush's greatest promoter, but Secretary of War Henry L. Stimson was almost as valuable. Like Roosevelt, Stimson developed a close relationship with Bush through their work together during World War II.[43] Although significantly less recognized as an essential ally than Roosevelt, Stimson was vital to Bush's success as an administrator and government official for several reasons.

Firstly, Stimson played a crucial role in clarifying Bush's behavior to other political figures and enhancing the efficacy of his political arguments. On one occasion, Bush recalled that he was meeting Roosevelt to seek approval on a report pertaining to atomic energy. The President was reluctant to read it, and Bush was attempting "mild prods" to convince FDR to approve the report. Stimson, who was at the meeting, then bluntly said, "Mr. President, what this

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41. "Secret Army," 1944, MIT Archives VB MSS (ref. 3).

42. The best example of this is James Conant, who went from the President of Harvard to High Commissioner of West Germany after Bush personally brought him into governmental research, recounted in Hershberg, *James B. Conant* (ref. 33), 127–28.

43. Reel 7-A, MIT Archives VB MSS (ref. 38).

damn Yankee means is he wants you to read it now."[44] The President then grinned and promptly marked the report with his signature "OK—FDR." In this humorous anecdote, the President was exhibiting an uncharacteristic reluctance to accede to Bush's unrelenting requests. Stimson had stepped in and supported Bush, and the decision went Bush's way.

Stimson also assisted Bush by helping him effectively articulate his policy positions. On the way to meet the British to discuss scientific affairs, Stimson attacked and questioned every one of Bush's points. Bush, irritated that Stimson appeared to dislike his arguments, was thus very surprised when the Secretary told him to handle the entire meeting when they arrived. Reflecting on that event, Bush said that "what Stimson had been doing was to make sure I had my arguments in order."[45] Considering Bush's tendency to unintentionally offend others, Stimson's attempts to clarify what Bush meant and improve his arguments were tremendously beneficial to his political career.

While Stimson certainly benefited Bush by refining his verbal interactions with others, he played an even more important role as a political ally during World War II. As the Secretary of War, Stimson was perfectly positioned to assist Bush by encouraging military support of his civilian research and preventing infighting. In both his wartime and postwar career, Bush often angered the military.[46] However, during World War II, such conflict was rarely an issue for Bush. His lack of concern was overlooked because Stimson, the head of the War Department, actively prevented the military from blocking Bush's reforms. Early in the war, Bush confided to the Secretary that the Army was pushing back on him. To this, Stimson replied, "Well, when you have trouble with the Army you bring it to me."[47]

On one such occasion during the war, Bush's fledgling wartime research group was experiencing personnel shortages and low morale because the military was refusing to acknowledge the scientists' draft deferments.[48] The Selective Service only honored draft deferments that were explicitly approved by the military and ignored the research contracts signed between Bush and the scientists of various universities. Bush desired that the research contracts he

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44. BBS Draft Notes, MIT Archives VB MSS, MC-0078, Box 17.

45. Reel 7-A, MIT Archives VB MSS (ref. 38).

46. Sapolsky, *History of the ONR* (ref. 5), 10–30; Reel 5-A OHI, MIT Archives VB MSS, MC-0143, Box 1.

47. Reel 11-A OHI, Section Title "Henry L. Stimson," MIT Archives VB MSS, MC-0143, Box 2.

48. Ibid.

signed automatically serve as approval, thus preventing any branch of the military from subsequently drafting his scientists.[49] This would also negate any requirement for a separate draft deferment decision made by the military, which threatened to disappear at any moment depending on shifting situations. When the Joint Chiefs of Staff came rushing to Stimson, angry about Bush's "absolutely absurd" campaign, the Secretary of War simply said, "Well that [Bush's campaign] seems to make sense to me . . . put it into effect."[50] These instances caused the military to view Bush as untouchable, particularly when coupled with his close relationship with President Roosevelt.

Secretary Stimson retired from office in September of 1945, roughly five months after President Roosevelt's death. His retirement removed from play the most essential figure in maintaining Bush's independence as a civilian science administrator. Coupled with the death of Franklin Roosevelt, Stimson's retirement caused Bush to lose his two most important allies in staving off the growing pressure and opposition from the military over Bush's control of and role in American research. This appears to explain why the military was largely unsuccessful at countering Bush's policies in wartime, yet kept him out of virtually every development in the postwar period.

Clashing with Truman

With Franklin Roosevelt's passing, Vice President Harry S. Truman ascended to the presidency. Initially, the new President and Bush appeared to have a strong professional relationship. In November 1945, Truman was planning a meeting with Prime Ministers Clement Attlee of Britain and Mackenzie King of Canada to discuss atomic energy. Bush was allowed to write the meeting's proposal to the United Nations with Lester Pearson of Canada and John Anderson of the United Kingdom.[51] This made Bush the only American involved in the process. The major role he played at this summit was recognized by Truman, who pulled Bush aside at the end of the conference and said, "Van, I want you to know that I realize that this would have been a balled up mess if you hadn't taken hold of it."[52] At the onset of the Truman presidency, Bush and the President were able to work together, and Bush remained in

49. Bush, *Pieces* (ref. 12), 288.

50. Reel 11-A, MIT Archives VB MSS (ref. 47).

51. Reel 11-B OHI, Section Title "Cabinet Meeting on Policy, Attlee Conference," MIT Archives VB MSS, MC-0143, Box 2.

52. Ibid.

control of American science policy. On his first encounter with Truman in the spring of 1945, in which he discussed the atomic bomb with the new president, Bush said:

> We got on a good basis of exchange at that first session. Later on he relied heavily on me, for a while, for information on scientific and technical matters. We had an interesting relationship, [while] it lasted.[53]

While Bush and Truman's relationship during and briefly after World War II appeared as though it could evolve into one similar to Bush and Roosevelt's, Bush remarked that shortly after the war, "it all stopped."[54] The President suddenly ceased working with Bush and rarely spoke to him. In his autobiography, *Pieces of the Action*, Bush expressed his confusion regarding why Truman distanced himself, stating that the only reason he could muster was that he had once feigned influenza to avoid attending a medal ceremony with the President.[55] He suspected that someone must have told the President about this attempt to avoid the ceremony, triggering their subsequent falling-out. Bush later stated that "I always thought, perhaps without reason, that I became inconvenient to Truman's palace guard and got poisoned. At any rate, all contact ceased. I never knew why . . . I got poisoned."[56] These "palace guard" to which Bush referred were the postwar scientific leaders who took on his former roles in government, especially John Steelman.

Faking the flu was most likely not the sole cause of Truman's loss of trust in Bush. Rather, the President's distancing of himself from Bush, and the science advisor's subsequent loss of influence in the White House, was caused by several other factors. Chief among these was the major difference in personalities, priorities, and beliefs between Bush and Truman. Despite similarities in political views to Franklin Roosevelt, Truman was vastly different in personality and public image. Truman was one of only a handful of modern presidents who never received a college degree, unlike the highly educated Roosevelt and Bush. The new, Midwestern president emphasized his status as a pragmatic man of the people, and likely held disdain for Bush's Yankee elitism.[57] In October 1945, when a reporter inquired about Truman's prior

53. Bush, *Pieces* (ref. 12), 293.

54. Reel 11-B, MIT Archives VB MSS (ref. 51).

55. Bush, *Pieces* (ref. 12), 299–302.

56. Ibid., 300–04.

57. Harry S Truman's everyman status is chronicled in David McCullough, *Truman* (New York: Simon & Schuster, 1993), 360.

dependence on Bush concerning atomic affairs, the president sarcastically replied, "if that's worth anything to you."[58]

A former scientific advisor to President Truman, William T. Golden, said in a later interview that "they [Bush and Truman] were both very strong-willed people" and that "there were some . . . personality tensions there."[59] With both men possessing strong and widely differing opinions, it is unsurprising that the President would eventually see Bush as an obstacle. While reflecting on the disagreements between Bush and Truman, Under Secretary of State and later NASA Director James Webb said that although Chief of Staff John Steelman's efforts to isolate Bush contributed to their rift, "the president himself never liked the old man [Bush]."[60] Both Golden and Webb held influential positions in the postwar administration, and implied that there was simply not enough common ground between Truman and Bush. The president was a progressive populist, whereas Bush was a political conservative representing the academic elite.

The factors contributing to Bush and Truman's rift are not necessarily unusual ones. Personal conflict in private settings had long been a common theme of politics among new presidential administrations and even in Bush's wartime research programs, with conflict over priorities leading to Bush's isolation of Lewis Strauss from early NDRC leadership, for example.[61] The disagreements between Bush and Truman, however, mark his fall as a particularly personal one, demonstrating the continued importance of the personal network in the midst of the postwar institutionalization of science.

CONTROVERSY OVER OSRD

With the protection afforded by Henry Stimson and Franklin Roosevelt no longer in play after World War II, Vannevar Bush's postwar decisions required significantly more political acuity to prevent angering the many politicians, scientists, and military officers in Washington. Nevertheless, Bush made several decisions after the war that drew enormous controversy, causing him to

58. Truman News Conference, Oct 1945, HSTL, quoted in Zachary, *Endless Frontier* (ref. 6), 300.

59. Interview with William T. Golden, 24 Jun 1989, HSTL Archives, OHI.

60. Interview with the Truman White House, 20 Feb 1980, HSTL Archives, OHI.

61. Reel 6-B OHI, MIT Archives VB MSS, MC-0143 Box 1; Hershberg, *James B. Conant* (ref. 33), 271–72.

become increasingly marginalized among important officials and pushed out of governmental affairs. Among these decisions was Bush's relentless advocacy for a rapid liquidation of the Office of Scientific Research and Development immediately after the war, despite frequent requests to maintain the organization. Bush believed that the OSRD should be closed for several reasons. One was that he thought the organization was overwhelmed by its wartime responsibility, and incorrectly assumed that all of its scientists would be eager to return to prewar conditions.[62] This was shortsighted because Bush failed to account for how much the scientists had become accustomed to the virtually unlimited funding they enjoyed during World War II. Scientists were concerned that a closure of the OSRD would bring a return to the prewar years of limited government subsidies.[63] To Bush, this was not a major concern—his financial success as a cofounder of Raytheon made it difficult to understand that young researchers in the OSRD relied heavily upon it for a salary. The second justification for his advocacy of the dissolution of the OSRD was that Bush wished for a new research organization to emerge in its place.[64] The OSRD was a wartime emergency establishment, forged from the broad authorization style of President Roosevelt. Bush believed that the organization possessed too many emergency powers and was not suitable for peacetime.[65] To carry out these beliefs, Bush drastically cut the staff of the OSRD to only twenty-six employees in 1947, infuriating the scientists who depended on the organization for pay and work.[66]

Bush's attempt to wind down the OSRD was extremely unpopular. Virtually everyone involved urged him to back down, including his close aide Oscar Ruebhausen. However, Bush did not relent and repeatedly told Truman of the importance of liquidating the organization.[67] Not only did this isolate him from his fellow researchers, but the constant requests to Truman about the issue likely irritated the president as well.

Of the many academics who felt endangered by Bush's attempts to put the OSRD out of service, those in the influential Radiation Lab at MIT were the most significant. During the war, the team at the Rad Lab made crucial advancements in microwave devices and radar technology. They were also the

62. Zachary, *Endless Frontier* (ref. 6), 248.
63. Ibid., 247–49.
64. Reel 11-A, MIT Archives VB MSS (ref. 47).
65. Zachary, *Endless Frontier* (ref. 6), 239–52.
66. Stewart, *Organizing Scientific Research* (ref. 1), 350, 384, 333.
67. Zachary, *Endless Frontier* (ref. 6), 240–47.

largest recipient of funding from the OSRD.[68] Led by physicist Lee DuBridge, the lab led an opposing campaign to preserve the OSRD. DuBridge had already fought with Bush during the war because Bush withheld one of the Rad Lab's funding checks simply on the suspicion that they were forgetting who was in charge.[69]

The controversy over whether to close the organization was heightened when President Truman wrote to those involved on June 8, 1945, assuring them that the agency would "not be liquidated at any early date . . . on the contrary it is imperative that the Office carry forward . . . and that it continue to function until a suitable agency is established to take over."[70] After this letter was sent, Bush made a major political blunder. Angrily informing Truman that the president was making a mistake, the science advisor "informed the president that he would send copies of his [own] letter to all those sent Truman's June 8 letter."[71] This move by Bush significantly harmed his relationship with the president. The timing was also unfortunate, as the incident coincided with the release of *Science: The Endless Frontier*, contributing to Truman's lukewarm response to the report.

Bush and James Forrestal

Two years after Stimson retired, Congress passed the National Security Act of 1947. This legislation created the National Military Establishment out of the previous War and Navy Departments and established a new cabinet-level head, the modern Secretary of Defense. This new position was filled by James Forrestal, the Secretary of the Navy. In contemporary sources, Forrestal is depicted as an advocate of Vannevar Bush.[72] Although he may have attempted to assist Bush in some cases, and even requested that the science advisor be his assistant, there is strong evidence that Forrestal was deeply disliked by Bush. When the position of Secretary of Defense was established, incumbent Secretary of War Robert Patterson was Harry Truman's preferred

68. Stewart, *Organizing Scientific Research* (ref. 1), 24, 176–77.

69. Zachary, *Endless Frontier* (ref. 6), 247.

70. Kevles, "Scientists, the Military" (ref. 19), 16; ibid., 250.

71. Zachary, *Endless Frontier* (ref. 6), 250; V. Bush to Harry Truman, 12 Jun 1945, NAS Archives, "Organization 1945, NAS RBNS General," quoted in Michael Dennis, "Reconstructing Sociotechnical Order: Vannevar Bush and US Science Policy," in *States of Knowledge: The Co-Production of Science and the Social Order*, ed. Sheila Jasanoff (New York: Routledge, 2004), 225–53.

72. Zachary, *Endless Frontier* (ref. 6), 322–23, 332–35, 340–42.

appointee.[73] However, Patterson declined the job, and the President was left seeking a new figure to appoint. Around this time, a *New York Times* article appeared, detailing Patterson's withdrawal and listing both Forrestal and Bush as potential candidates for the position.[74] While Forrestal was certainly viewed as the favorite in the race for Secretary of Defense, Vannevar Bush greatly desired the job as well. Scientific consultant Edward Bowles wrote in his office diary that "Bush wants the job in the worst way."[75]

Given the conflict between the two, Truman would never have appointed Bush to be Secretary of Defense; however, this did not stop Bush from eagerly pursuing the role, nor from harboring significant hope that he would ultimately prevail. In pursuing the position, Bush was "hopeful enough that he asked at least one colleague to work for him in the Pentagon."[76] His effort failed, and Bush was forced to accept a different position: Chairman of the Research and Development Board.[77] Stipulated in the same 1947 legislation that created the Defense Department, the R&D Board was an advisory group that succeeded the Joint Research and Development Board.[78] It was in this final position that Bush's isolation and frustration would eventually grow to a point that he quit government service in 1948.

In *Pieces of the Action*, Bush spoke very little of Forrestal. The rare entries on him are generally neutral, detailing how Forrestal helped Bush in confirming his appointment as chair of the R&D Board.[79] However, in a later-removed paragraph among Bush's personal drafts of his autobiography, he wrote clearly of his dislike and resentment of James Forrestal:

> That about marked my exit from the national scene. Soon I was to give up, also, my position on the Research and Development Board. That was a frustrating experience, and I finally cracked up a bit under it. I had plenty of responsibility, but no backing from Secretary Forrestal. How could he back me, in the job of sorting matters out between services? He never should have become Secretary of Defense; as Secretary of the Navy he had

73. Steven Rearden, *History of the Office of the Secretary of Defense*, vol. 1, *The Formative Years, 1947–1950* (ACLS Humanities E-Book, 2014), 29.

74. Leviero, "Patterson Reported Quitting" (ref. 13).

75. Edward Bowles, Office Diary, 23 Jun 1947, Bowles Papers (ref. 13); Zachary, *Endless Frontier* (ref. 6), 322; S. Lovell to Harry Truman, 2 Apr 1947, HSTL Archives, Official File 53, 46-53.

76. Zachary, *Endless Frontier* (ref. 6), 322.

77. Bush, *Pieces* (ref. 12), 299–303.

78. Ibid., 303; National Security Act of 1947, Pub. L. No. 115–232, 61 Stat. 496 (1947).

79. Bush, *Pieces* (ref. 12), 302–04.

vigorously opposed unification, and then he stepped in to administer it. We all know the result. I should have had sense enough not to get involved in an impossible situation.[80]

Though these insightful sections were removed from later drafts of *Pieces of the Action*, Bush's complaints of "no backing from Secretary Forrestal" and his claim that Forrestal "never should have become Secretary of Defense" reflect his deep dissatisfaction with the Secretary.

Bush's resentment of Forrestal was additionally motivated by a variety of factors beyond being snubbed for Defense Secretary. Whereas former Secretary of War Stimson often placed Bush's opinions above those of the Armed Forces, Forrestal almost always sided with the military and prioritized their needs. In this respect, the two secretaries were completely different and had entirely different effects on Bush's political situation. In the same earlier drafts of *Pieces of the Action*, Bush also wrote about his stint at the Research and Development Board, claiming "Forrestal didn't back me up . . . this Board really was not powerful. I had very little authority simply because the only times I tried to do anything, Forrestal really didn't back me up."[81] Although Stimson certainly supported the military, his personal friendship with Bush and understanding of the value of civilian leadership of research prompted him to take Bush's point of view over the military's whenever a conflict arose between them. This was the polar opposite of Forrestal, who placed the Armed Forces' opinions above those of civilian researchers.

Another source of Bush's resentment of Forrestal may have been over the appointment of Lewis Strauss as scientific advisor while Forrestal directed the Navy.[82] Strauss had been a vocal opponent of many civilian scientific leaders of the time, including Oppenheimer and Bush. That personal dislike of Bush stemmed from the early days of World War II, when Bush and Conant prevented Strauss from serving as Naval advisor at the NDRC.[83] These motivations led Strauss to recommend Forrestal appoint Admiral Harold Bowen as head of the newly created Office of Research and Inventions, a replacement of the Office of Patents and Inventions, in May 1945.[84] Admiral Bowen— a known political enemy of Bush's who had previously been humiliated by

80. BBS Drafts, MIT Archives VB MSS (ref. 44), Box 2, Folder 8, pages 57–58.
81. Reel 6-A, MIT Archives VB MSS (ref. 15).
82. Alden Whitman, "Lewis Strauss Dies; Ex-Head of A.E.C.," *NYT*, 22 Jan 1974.
83. Reel 6-B, MIT Archives VB MSS (ref. 61).
84. Sapolsky, *History of the ONR* (ref. 5), 24–25, 27, 30–35.

Bush during World War II—was given complete control over the Navy's research program.[85] This move by Strauss and Forrestal jeopardized Bush's already-threatened political situation, and likely contributed to his quiet grudge against the Defense Secretary.

James Forrestal was never attacked directly by Bush and is seen on the surface to be a supporter of him, it appears that Forrestal's appointments and priorities, coupled with his ascension as Secretary of Defense at the expense of Bush, caused the former science advisor to resent him to the point that Bush left the R&D Board in 1948. While Bush's opinion would occasionally be sought in part-time advisory roles such as the State Department's Panel on Disarmament in the 1950s, occasional meetings with the Eisenhower administration, and testimony before Congress including a 1957 visit over Sputnik at the behest of then-senator Lyndon B. Johnson, Bush's role as the principal architect of national science policy would never again be recaptured.[86] When he quit his last full-time policy position in government, Bush effectively ended his now-waning role as science administrator.

CONFLICTS WITH THE MILITARY

As the civilian coordinator of virtually all government-funded research during World War II, Vannevar Bush was often at odds with the Armed Forces. The first major disagreement between Bush and the military involved draft deferments which, as discussed earlier, caused opposition that was only overcome by the intervention of Henry Stimson. In addition to the argument over the drafting of scientists, Bush also clashed with the military about secrecy. During the war, Bush often failed to notify many in the Armed Forces about new developments in research. Writing on Bush's role in the decision to build the atomic bomb, Stanley Goldberg noted that Bush "was able to fund the entire American effort in building the atomic bomb without congressional advice and

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85. For Strauss and Forrestal's role in the appointment, see ibid. Bush's wartime actions included removing Admiral Bowen as head of the Naval Research Laboratory and having him given an unsatisfactory fitness report, events recounted in Harold Bowen, *Ships, Machinery, and Mossbacks: The Autobiography of a Naval Engineer* (Princeton, NJ: Princeton University Press, 1954), 229–31; James Baxter, *Scientists Against Time* (Cambridge, MA: MIT Press, 1968), 170–75.

86. Bush's activities in the State Department and the Eisenhower administration are documented in Zuoyue Wang, *In Sputnik's Shadow: The President's Science Advisory Committee and Cold War America* (New Brunswick, NJ: Rutgers University Press, 2009), 42–45. For an account of Bush's 1957 Congressional testimony, see Zachary, *Endless Frontier* (ref. 6), 388.

consent."[87] After his retirement, Bush remarked that he was "cursed in various circles" for his lack of transparency during the war.[88] Although the military was certainly just as guilty as Bush of secrecy and compartmentalization during World War II, they were nevertheless increasingly frustrated by his efforts to keep them out of the loop in scientific matters.[89] These conflicts were prevented from further escalation by President Roosevelt, who supported Bush's secrecy to the point of never even notifying then-Vice President Harry Truman about the Manhattan Project.[90]

During the war, Bush also clashed with the military over the research budget. Despite his strong support for the budgets of civilian-led research projects, Bush often recommended cutting the funding for military-led research—actions that he later reported "caused quite a howl."[91] With tensions mounting in the military over Bush's handling of their research budget, it was inevitable that he would draw the ire of Budget Director Harold Smith. Smith had a wartime suspicion that Bush was misusing government funds, was jealous of Bush's friendship with President Roosevelt, and became fixated on destroying Bush's influence.[92] After the war, Smith launched a personal campaign against Bush, vocally attacking him and mocking his policies. Smith took steps to form a personal "coalition against Bush" within the White House, undermining Bush's political influence.[93] One of the few admirals who had supported Bush during the war, Julius Furer, was persuaded by Smith to distance himself from both Bush and the civilian scientists.[94] The Budget Director derisively christened Bush's paramount report to the President *Science: The Endless Expenditure* after it was released.[95]

87. Stanley Goldberg, "Inventing a Climate of Opinion: Vannevar Bush and the Decision to Build the Bomb," *Isis* 83, no. 3 (1992): 429–52, on 450.

88. Reel 4-B, MIT Archives VB MSS (ref. 37).

89. Vincent Davis, *The Politics of Innovation: Patterns in Navy Cases* (Denver: University of Denver, 1967), 25; Sapolsky, *History of the ONR* (ref. 5), 18–19.

90. Bush, *Pieces* (ref. 12), 293.

91. Reel 5-A, MIT Archives VB MSS (ref. 46).

92. Vannevar Bush, "The Special Need for Federal Support," in *Science, the Endless Frontier* (Washington, DC: United States Government Publishing Office, 1945); https://nsf.gov/od/lpa/nsf50/vbush1945.htm#ch3.8 (accessed Jul 2021). The conflict between them is covered in Zachary, *Endless Frontier* (ref. 6), 244–51.

93. Daniel Kevles, *The Physicists: The History of a Scientific Community in Modern America* (Cambridge, MA: Harvard University Press, 1971), 356.

94. Harold Smith to Julius Furer, 14 Jun 1945, Furer Papers LOC, Series 2.

95. Harold Smith to C. L. Wilson, 19 Jul 1945, OSRD National Archives, Box 2, Series 2.

Bush rarely saw eye-to-eye with the military, which is evident in countless examples of the two sides' varying actions and beliefs.[96] There was conflict over broad policy features, such as whether to include production of technology under R&D funding, prompting disagreement between Bush and Air Force generals including Benjamin Chidlaw and Kenneth Wolfe.[97] The fundamental separation between these two groups, however, was not due to a lack of support by Bush for research directly relevant to national security. Rather, Bush advocated for and created a structure of governance that placed civilians in control of research organizations. The primacy of civilian leadership in Bush's wartime programs, as well as more specific policy issues, provided the source of frequent tension. However, those disagreements all had one under-lying commonality: though held in check during the war due to Bush's friend-ships with Stimson and Roosevelt, they jeopardized his political standing once the war was over.

Bush's postwar conflicts with the military tended to manifest as disagree-ments over research priorities, i.e., over which technology to pursue. In his career as a director of research organizations, Bush tended to limit investment in research projects that he personally deemed unfeasible.[98] During the war this had enabled him to manage his groups efficiently and prevented over-extending the organizations he led, but it also kept him out of many new scientific developments and alienated him from the advocates of certain new technologies.

Bush's first conflict over research priorities with the military involved rock-etry. During World War II, Bush was highly critical of the guided missile program and rocketry, arguing that they were not feasible.[99] He maintained this view after he quit government service, writing in *Modern Arms and Free Men* that he doubted ballistic missiles would emerge as a dominant force "for a long time to come...if ever."[100] Dismissing the technology as a mere "fantasy," Bush argued that missiles were irrelevant when a payload can be delivered by an airplane.[101] Leaders of the newly established Air Force,

96. For a detailed account of these wartime relations, see Sapolsky, *History of the ONR* (ref. 5), esp. 15.

97. Lassman, *Weapon Systems Innovation* (ref. 5), 109–10; Owens, "Counterproductive Management of Science" (ref. 1), 554.

98. Vannevar Bush, *Modern Arms and Free Men* (New York: Simon & Schuster, 1949), 110–21.

99. Hershberg, *James B. Conant* (ref. 33), 393.

100. Bush, *Modern Arms* (ref. 98), 116.

101. Ibid., 121.

however, placed a very high priority on such technology, using its potential value and relevance as a means of strengthening the branch's influence amidst fierce competition within the Armed Forces.[102] Bush's opposition to their research priorities was therefore vastly unpopular. Air Force Chief Henry "Hap" Arnold formed a "Scientific Advisory Group" to determine policy and research within the Air Force and placed a special focus on rocketry. Instead of Bush, Arnold appointed California Institute of Technology professor and rocket enthusiast Theodore von Kármán as head of the group and did not even include Bush as a member. Both Arnold and von Kármán shared the view that guided missiles were the future. This isolated Bush. Von Kármán later remarked that to include Bush "would only injure progress in Air Force research."[103] At a press conference held in the years after Bush's retirement, Air Force General Thomas D. White proclaimed that Bush was "not only egregiously in error in many scientific forecasts, but unconsciously perhaps, epitomized the desire to ignore the implications of advances in weaponry."[104]

Bush's dogged defense of his policies and his conflicts with the military continued for the rest of his life, extending even into the space program. As with rocketry, the Air Force supported it, while Bush opposed it. He believed that "to put a man on the moon is folly, engendered by childish enthusiasm. It will backfire on those who drive it ahead."[105] He corresponded with senators and spoke at congressional committees frequently to advocate against the space program from its inception.[106] Already wary of Bush from earlier disagreements, the military, especially the Air Force, viewed him as a serious opponent of their progress, highlighting substantial disputes that even decades away from government service could not quiet.

As Bush continued to oppose the military on various technological fields, many inside the military's command structure began to view Bush as limited in vision. In the context of rising Cold War tensions and increased public support

102. The early years of the Air Force branch, particularly their continued competition with other military branches, are recounted in Carl Borklund, *The Department of Defense* (New York: Frederick A. Praeger, 1968), esp. 19–24.

103. Theodore von Karman, *The Wind and Beyond: Theodore von Karman, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown, 1967), 271–72.

104. General Thomas D. White on Aerospace Power, Bush Papers Tufts Archives, MS 169, Box 1.

105. Vannevar Bush, "Letters to the Times; Moon Shot Opposed, Vannevar Bush Says Program Not Worth Dangers Involved," *NYT*, 17 Nov 1963.

106. Reel 6-A, MIT Archives VB MSS (ref. 15); V. Bush to William Proxmire, 1962, Bush Papers Tufts Archives, MS 169, Box 1.

for national security initiatives, Bush's opposition to certain technologies, and his suspicion of the non-civilian direction of science policy, was increasingly out of step with geopolitical trends. The military's past wartime disputes with him reemerged. While the disagreements over aerospace technology harmed his relationship with the Air Force, Bush also lacked allies in the Army and experienced harsh pushback from the Navy. Harvey Sapolsky writes that Bush "deftly ignored criticism" from the military regarding "scientists who refused direction."[107] Bush's conflict with the military was not solely about whether to draft scientists or to reduce the budget. Rather, it was based on whether a civilian administrator or a military officer should direct the scientific research that fueled both domestic progress and national security. Bush championed civilian independence; the military, however, saw him as obstructive and insubordinate.

Younger officers also viewed Bush as too resistant to progress. After being restored by Forrestal as head of the Office of Research and Inventions, Admiral Bowen fostered the growth of a new group of young military officers, nicknamed "bird dogs" for their role in locating problems within the Navy.[108] Indignant that Bush had submitted a proposal for a postwar research and development organization, they created a competing plan that advocated for consolidated military power. The bird dogs then received approval from Forrestal, largely through the support of older officers like Admirals Harold Bowen, Ernest King, and Julius Furer.[109] The bird dogs christened their organization the Office of Naval Research, and successfully pushed Bush out of involvement.[110] The ONR quickly became the dominant patron for research in the physical sciences because of the applications to national security. In this development, the role of personal networks in science policy was not completely supplanted by institutionalization in the postwar period; rather, it was an important method by which such permanent institutions arose. With the rise of Naval patronage in research came broader military involvement, as the Army and Air Force developed their own institutions to support relevant technology, such as the funding of solid-state physics by the Army Signal Corps.[111]

107. Sapolsky, *History of the ONR* (ref. 5), 30.

108. Bruce Old, "The Evolution of the Office of Naval Research," *Physics Today* 14, no. 8 (1961). See also Zachary, *Endless Frontier* (ref. 6), 230–33.

109. Sapolsky, *History of the ONR* (ref. 5), 19–23, 26.

110. Ibid., 20–25.

111. Thomas J. Misa, "Military Needs, Commercial Realities, and the Development of the Transistor, 1948–1958," in *Military Enterprise and Technological Change: Perspectives on the*

By creating the ONR, the Navy gained a foothold into American scientific patronage of universities, a world previously dominated almost exclusively by civilian scientists and private foundations.[112] The rise of the ONR as the dominant scientific patron in the immediate postwar period was a direct consequence of the aggravated personal conflict between Bush and the Armed Forces over research policy. Among academics, this was seen as a failure of Bush's promises to ensure their independence from the Armed Forces. This incident both alienated Bush from the scientists and strengthened the military's enmity toward him, among both the older officers and young bird dogs.

After the breakdown of his relations with the Navy and founding of the ONR, Bush proposed what he considered his "most important organizational innovation since the end of the war."[113] Bush recruited many of his wartime colleagues, including MIT Rad Lab pioneer I. I. Rabi, wealthy scientist and benefactor Alfred Lee Loomis, Bell Labs manager William Shockley, and the future president of the Carnegie Institution of Washington, Caryl Haskins. Christening the new program the Weapons Systems Evaluation Group, Bush proposed the program to James Forrestal in early 1948.[114] In the proposal, Bush stipulated a couple of requests for the organization. The first, and most important, request was that it exist completely independently from the military and be led entirely by civilian researchers. The second was that the organization would make the final decision on whether a weapon was feasible, and therefore whether it would be pursued. The plan to develop the Weapons Systems Evaluation Group went nowhere. The military, threatened by Bush's advocacy of a civilian-led research enterprise that resembled his wartime programs, furiously attacked the proposal and countered by demanding that if Bush's proposed organization was formed, the Armed Forces must be able to create its own, separate, parallel one. This essentially killed Bush's proposal, although a very different group with the same name would be established the following year in 1949, controlled by the Joint Chiefs.[115] In a 1948 letter to

American Experience, ed. Merritt Roe Smith (Cambridge, MA: MIT Press, 1985), 253–88; Forman, "Behind Quantum Electronics" (ref. 26), on 204.

112. The role of private foundations in the early twentieth century is recounted in Kevles, *The Physicists* (ref. 93), esp. 148–51, 185–99; Mark Solovey, *Social Science For What?: Battles over Public Funding for the "Other Sciences" at the National Science Foundation* (Cambridge, MA: MIT Press, 2020), 100–06.

113. Zachary, *Endless Frontier* (ref. 6), 339–45.

114. Ibid., 339–40.

115. Ibid. 341; Paul Gorman, declassified memorandum Weapons Systems Evaluation Group, 23 Sep 1980, Joint Chiefs of Staff, https://fas.org/man/eprint/wseg.pdf (accessed 24 Nov 2020).

Frank Jewett shortly after his resignation, Bush bitterly said, "I seem to be getting the short end thus far."[116]

After his Weapons Systems Evaluation Group proposal was killed by the military, Bush had only one remaining position in governmental research: he was the chairman of the Research and Development Board, the successor to the JRDB. Although Bush was officially in charge, the military continued to limit his efforts. The Joint Chiefs kept Bush out of the loop in scientific affairs, banishing the R&D Board to irrelevance in military research policy.[117] Whenever Bush left town for a holiday or break, the military aggressively interfered with his research team, giving orders and taking their information.[118] On his years as head of the R&D Board, Bush remarked he had "very little authority" and that "a few years of it finished off my government service in a whirl."[119] Nearly all of Bush's postwar attempts to retain power, from the JRDB to his continued attempts to stay relevant in military research, were countered due to his poor relations with the military. The personal conflict between Bush and the military also contributed to the rise of institutions like the ONR to direct research.

Although conflict with military leaders contributed to Bush's retirement, it is important to note that General Leslie Groves was not one of his adversaries. Initial disagreements between Bush and Groves in the early years of the Manhattan Project have been taken by some as the beginning of Bush's troubles with the Armed Forces.[120] However, after his initial judgment of Groves, Bush became close friends with the army engineer.[121] Throughout World War II and the Manhattan Project, Bush came to respect Groves's abilities and "got along excellently after the first encounter which is recited

116. V. Bush to Frank Jewett, 3 Aug 1948, Carnegie Institution of Washington Archives, quoted in Zachary, *Endless Frontier* (ref. 6), 341.

117. Despite the purpose of the R&D Board as an advisory group, Bush was never invited to a single meeting with the Joint Chiefs, recounted in Townsend Hoopes and Douglas Brinkley, *Driven Patriot: The Life and Times of James Forrestal* (Annapolis, MD: Naval Institute Press, 1992), 362.

118. Reel 6-A, MIT Archives VB MSS (ref. 15).

119. Ibid.

120. Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 1987), 427; Hershberg, *James B. Conant* (ref. 33), 161–62.

121. V. Bush to Leslie Groves, 2 Dec 1960, MIT Archives VB MSS, MC-0078, Box 20; Leslie Groves, *Now It Can Be Told: The Story of the Manhattan Project* (Cambridge, MA: Da Capo Press, 1983), 20–21; Nathan Reingold, *Science, American Style* (New Brunswick, NJ: Rutgers University Press, 1991), 285.

in [Groves's] book."[122] Although a friendship with Groves may have benefited Bush's wartime relationship with some parts of the military, the return of frontline generals to peacetime military administration led to an eclipse of Groves, eliminating the political value of Bush's relationship with him. As the postwar period continued, Groves became increasingly marginalized. He lost control of atomic affairs after the formation of the Atomic Energy Commission, and left the Army after it became apparent that he lacked the standing enjoyed by combat generals returning from war.[123] This ultimately placed Groves in a similarly isolated position as Bush, preventing him from salvaging Bush's rapidly deteriorating relationship with the Armed Forces.

In the postwar years, Bush's conflicts over supremacy in research governance with military leaders were many and fierce. Military opposition to his plans and his subsequent personal isolation contributed heavily to his retirement from government in 1948, and cast light on the rise of the military as the dominant institution for postwar research funding.

DEBATE OVER THE NATIONAL SCIENCE FOUNDATION

Following the controversy over the closure of the OSRD, Bush became embroiled in another dramatic political event, the protracted conflict over establishing the National Science Foundation.

Arguments about the postwar era's handling of federal patronage of research were in consideration well before World War II ended.[124] As early as 1943, Senator Harley M. Kilgore (Democrat, West Virginia) introduced progressive legislation proposing an organization that would manage government support for research after the war. This legislation was poorly received among scientists, and Bush became involved in the debate with Kilgore.[125] Despite having differing views, Bush was initially quite magnanimous about the Senator's controversial bill. He wrote a letter to Kilgore about the legislation, arguing for a separate view but commending Kilgore's drive and concern for the public

122. Reel 7-B, MIT Archives VB MSS (ref. 39).

123. Robert Norris, *Racing for the Bomb: General Leslie R. Groves, the Manhattan Project's Indispensable Man* (Hanover, NH: Steerforth Press, 2002), 502–04; Reel 6-B, MIT Archives VB MSS (ref. 61).

124. Kevles, "Debate over Postwar Research" (ref. 19), 10–11.

125. Ibid., 9.

interest.[126] However, as the Kilgore Bill advanced through Congress and Kilgore's call for reform grew louder, presidential advisor Harry Hopkins and lawyer Oscar Cox decided to have President Roosevelt request advice from Bush on research policy, which would compete with the Kilgore Bill.[127] This request by Cox and Hopkins, coupled with Bush's informal conversations with Roosevelt regarding postwar research, were the impetus for Bush's famous report *Science: The Endless Frontier*.

Roosevelt's death and Truman's subsequent ascension to the presidency jeopardized the chances of Bush's report being enshrined into law. To protect its release, Bush met with Kilgore in May 1945 and promised to "collaborate fully" with him on the formation of the new research organization.[128] In the meeting, Bush even suggested that they draft a joint bill to be introduced to Congress. The meeting was a success, and Kilgore backed off the legislation, instead preparing to work with Bush. While Kilgore interpreted the meeting as a promise of collaboration, Bush either forgot about the agreement or merely ignored it. He had Senator Warren Magnuson (Democrat, Washington) introduce the Magnuson Bill to Congress immediately after the release of *Science: The Endless Frontier*, and never worked with Kilgore on a joint bill.[129] This move infuriated Kilgore, who felt "doublecrossed" and "mad as anything," as reported by Reubhausen.[130] Kilgore introduced his own legislation and sparked a debate that would continue for several years.

Multiple pieces of legislation would be proposed over the course of the debate, typically supported by either Bush or Kilgore. The pitched battles over policy that delayed formation of the NSF are well documented. Bush-backed legislation supported a distribution of funds based primarily on scientific reputation, while Kilgore advocated for geographic apportionment.[131]

126. Vannevar Bush, "The Kilgore Bill," *Science*, 31 Dec 1943, 98.

127. Oscar Cox to Harry Hopkins, 13 Oct 1944, Oscar S. Cox Papers, FDR Presidential Library, Hyde Park; Kevles, "Debate over Postwar Research" (ref. 19), 16.

128. V. Bush to Kilgore, 15 May 1945, NARA, RG 227, Office of Scientific Research and Development, quoted in Robert Maddox, *The Senatorial Career of Harley Martin Kilgore* (East Rockaway: Cummings & Hathaway, 1997), 166; Zachary, *Endless Frontier* (ref. 6), 253–54.

129. J. Wang, "The NSF Debate Revisited" (ref. 22), 143; Maddox, *The Senatorial Career* (ref. 128), 166–67.

130. Oscar Reubhausen, interview by G. Pascal Zachary, in *Endless Frontier* (ref. 6), 254.

131. Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill: The University of North Carolina Press, 1999), 31; Vannevar Bush, "Centers of Basic Research," in *Science, the Endless Frontier* (Washington, DC: United States Government Publishing Office, 1945).

Legislation proposed by Kilgore tended to support the social sciences to a much higher degree than Bush, who wished funding be provided for social sciences by "other channels," if at all.[132] Debates over censorship and patent licensing also arose, with Bush arguing for less availability of research to the public.[133] Additionally, as Jessica Wang has noted, Kilgore's bills were reminiscent of "New Deal planning."[134] Although Bush may have worked with many New Deal politicians (Roosevelt among them) during wartime, he was never a strong supporter of the reforms, and surely never applied them to his largely independent role as science administrator. Overall, these broad political disagreements complicated the legislative process and contributed mightily to protracting the debate. Less commonly discussed, however, is the remarkably large amount of personal conflict between Bush and both politicians and scientists. Bush's actions during the NSF debate provide a unique context for both the delayed creation of the NSF and the factors affecting his fall from power.

Among politicians, the liberal members of Congress were indignant at Bush's treatment of Kilgore and his "elite-driven conception of science policy."[135] Both the Kilgore and Magnuson bills stalled in Congress, dying out in a political stalemate. The debate would continue when Alexander Smith proposed a bill similar to the Magnuson Bill. This Bush-backed legislation passed in 1947, largely due to the Republican majority in the newly elected 80th Congress.[136] However, in an unanticipated move, Kilgore, Harold Smith, Don Price, and other political allies wrote memoranda and had personal conversations that convinced the already-hesitant Truman to veto the bill.[137] Significant legislative debate would continue following the veto, with the Republican-controlled 80th Congress staunchly opposing progressive legislation. Kilgore's conflict with Bush led to the use of personal networks to undermine Bush's policies, prolonging the NSF debate. Bush spent the remainder of his national service attempting to convince President Truman to sign the bill if it passed again. The National Science Foundation would

132. V. Bush to D. C. Josephs, 19 Sep 1946, NARA, RG 227, Bush Papers, Box 14, quoted in Solovey, *Social Science for What* (ref. 112), 25.

133. Daniel Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, NC: Duke University Press, 1995), 121–25, esp. 124; Solovey, *Social Science for What* (ref. 112), 37; Kevles, "Debate over Postwar Research" (ref. 19), 15.

134. J. Wang, *American Science* (ref. 131), 27–30, on 28.

135. J. Wang, "The NSF Debate Revisited" (ref. 22), esp. 140.

136. Kevles, "Debate over Postwar Research" (ref. 19), 25.

137. Ibid.; Reel 4-A OHI, MIT Archives VB MSS, MC-0143, Box 1. Don Price's role is recounted in Kevles, *The Physicists* (ref. 93), 361–62.

finally be created in 1950, three years after Truman's veto and two years after Bush had resigned from government service.

The debate over the National Science Foundation proved harmful to Bush's relationship with many academics, as his personal opinions on the value of various fields of research were publicized. Scholars supporting the social sciences, including Henry Allen Moe and the members of the Social Science Research Council, were angered by Bush's disdain and lack of support for the social sciences.[138] This led them to deny endorsement of Bush-backed proposals, including the Magnuson Bill, and support the more progressive Kilgore Bill, which included a specific section on social science.[139] The humanities had not forgotten the slights that Bush made against them during his tenure at the Carnegie Institution of Washington, which had included slashing funds for the history of science journal *Isis* and jokingly threatening to kill George Sarton after the editor appealed to a trustee of the organization.[140]

In addition to academics from the social sciences and humanities, Bush also found himself at odds with many biologists from the National Academy of Sciences.[141] Many of the scholars in the field felt that both *Science: The Endless Frontier* and the Magnuson Bill spurned biology in favor of medicine. Indignant biologists argued that Bush's Magnuson Bill would distort the field into a mere "handmaiden of medicine."[142] This suspicion was rooted in Bush's leadership during World War II, in which his OSRD often prioritized medicine over the broader field of the life sciences. This difference was part of the wartime focus of Bush who, as an engineer, had favored the application of science over more general fields.[143]

Harley Kilgore would play another key role in motivating Bush's resignation by helping convince President Truman to appoint John Steelman, a former sociology and economics professor, as scientific advisor. Steelman was a prominent postwar rival of Bush who played a role in replacing Bush with his appointment to the President's Scientific Research Board.[144] Steelman's

138. The role of social sciences in both bills is seen in Solovey, *Social Science for What* (ref. 112), 25–46; J. Wang, "The NSF Debate Revisited" (ref. 22), 142–45.

139. J. Wang, "The NSF Debate Revisited" (ref. 22), 143; McElroy Interview, 15 Oct 1969, MIT Archives VB MSS (ref. 40), 18.

140. Zachary, *Endless Frontier* (ref. 6), 94.

141. Reingold, "Bush's New Deal" (ref. 22), 335–38.

142. Ibid., 336.

143. Ibid., 313; Kline, "Construing 'Technology'" (ref. 2), 218.

144. J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945–57* (Washington, DC: National Science Foundation, 1983), 62–63; Robert

appointment, done at Kilgore's urging (likely because of both political beliefs and a dislike of Bush), led to yet another enemy of Bush receiving powers the former science advisor had previously possessed. Ultimately, personal conflict between Bush and Kilgore would play a part in both the continuation of the NSF debate and the further diminution of Bush's authority.

Bush, relegated to a role as a spectator and occasional ad hoc advisor in research leadership after his 1948 departure from government, saw the 1950 creation of the National Science Foundation as a failure. The organization had undergone too many compromises and was far different from the National Research Foundation described in *Science: The Endless Frontier*. In one of his only direct interventions into Bush's professional affairs after World War II, his close friend and former colleague James Bryant Conant wrote a scathing 1971 essay in the *Bulletin of the New York Academy of Medicine*. Titled "An Old Man Looks Back," Conant's essay informed the public on how Vannevar Bush's plan was nothing like the modern NSF. He lamented that by 1950, the military's Office of Naval Research was so dominant that the NSF had little room to expand. Two years after the ONR was founded, its budget was at $30 million a year.[145] After a similar time interval, appropriations for the NSF were below $5 million a year.[146] The timing was unfortunate for the NSF, as the ONR had emerged after the war to fill in the massive postwar funding vacuum created by the eventual shutdown of the OSRD. The eruption of conflict in Korea and mounting Cold War tensions strengthened the military's justification for a central role in science policy. On the government's removal of Bush and mutilation of the plan laid out in *Science: The Endless Frontier*, Conant declared, "I cannot help saying something which old men should be forbidden to say, namely: 'I told you so.'"[147]

Conant's essay echoed growing frustration with military intervention in science policy, particularly among student protestors.[148] The extended time

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Maddox, "The Politics of World War II Science: Senator Harley M. Kilgore and the Legislative Origins of the National Science Foundation," *West Virginia History* 41, no. 1 (1979): 20–39, on 22.

145. John Pfeiffer, "The Office of Naval Research," *Scientific American*, Feb 1949, 11–15.

146. *NSF Requests and Appropriations by Account: FY 1951 – FY 2020*, National Science Foundation, https://dellweb.bfa.nsf.gov/NSFRqstAppropHist/NSFRequestsandAppropriationsHistory.pdf (accessed Jul 2021).

147. James Conant, "An Old Man Looks Back: Science and the Federal Government," 1979, MIT Archives VB MSS, MC-0078, Box 3.

148. For the fierce conflict between university protestors (physicists in particular) and the Armed Forces over military control of funding, see Kelly Moore, *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945–1975* (Princeton, NJ:

of debate before its establishment as law meant the NSF was born into a world of research with considerably more military involvement than Bush had originally envisioned. Conant wrote that "by the time a National Science Foundation was finally established . . . the Office of Naval Research had already entered into contractual relations with a number of leading universities, and most of these contracts did not preclude work on secret projects."[149] This sentiment has been discussed by Daniel Kevles, who characterized the Korean War as the pivotal event by which growing military presence in 1950s science policy was secured.[150] From personal conflict came the establishment of large, often military-led institutions like the ONR that both funded science and worked to secure their own supremacy. The protracted debate over founding the NSF was essential to the removal of Bush from control of research. More importantly, it harmed the very scientific independence for which he strove.

There has been debate among historians of science as to whether the establishment of military supremacy in postwar science policy was an inevitable outcome of geopolitical trends. In addressing the argument made by Paul Hoch that military dominance in science resulted from the delay in forming the NSF, Jessica Wang has contended that the shift in military dominance was indeed an inevitable one, a consequence of the Cold War.[151] However, the years of World War II saw no similar ousting of civilian control, despite strong military incentive to do so. The lack of substantial wartime military interference in research cannot be attributed solely to a lack of understanding of the value of research funding. Indeed, even in 1943 the "bird dog" naval officers had established plans to capitalize on basic research funding.[152] Although the military control of postwar science was certainly shaped by international trends in politics relating to the Cold War, it was not completely determined by them. The gradual shift in style of policymaking away from personal networks and toward permanent, public institutions seen during the fall of Bush was also an important factor. Only after the ousting of Bush from power, and his later

Princeton University Press, 2008); David Kaiser, "Cold War Requisitions, Scientific Manpower, and the Production of American Physicists after World War II," *HSPS* 33, no. 1 (2002): 131–59.

149. Conant, "An Old Man Looks Back" (ref. 147).

150. Kevles, "Cold War and Hot Physics" (ref. 26), 259.

151. Paul K. Hoch, "The Crystallization of a Strategic Alliance: The American Physics Elite and the Military in the 1940s," in vol. 1 of *Science, Technology and the Military*, ed. Everett Mendelsohn, Merritt Roe Smith, and Peter Weingart (Dordrecht: Kluwer Academic Publishers, 1988), 87–111, on 104; J. Wang, "The NSF Debate Revisited" (ref. 22), 163.

152. Sapolsky, *History of the ONR* (ref. 5), 9–11; Old, "Evolution of the ONR" (ref. 108), 32.

complete retirement from Washington in the 1950s, did scientific policymaking completely shift to public settings, including those dominated by the Armed Forces. Moreover, the structure, jurisdiction, and policy frameworks of these new institutions were clearly influenced by the individual political networks that predated them.

CONCLUSION

Throughout his postwar government career, Vannevar Bush's persistent conflicts reached such an intensity that they began to impact his mental health. When he finally retired in 1948, Bush suffered from severe headaches and anxiety.[153] It was much more, however, than the typical stress of public service. Anxiety and stress had plagued Bush before, including shortly after the Trinity Test in 1945.[154] When later reflecting on the anxiety and exhaustion he felt during the Manhattan Project, Bush stated that he "went down to Cape Cod for two or three days and there relaxed and got some of the tension off."[155] He described, however, his recovery, and that "all of us [involved in the project] not only felt greatly relieved; we felt that it was the end of a long struggle."[156] Bush's anxiety during the postwar was significantly more intense, leading him to take time away from his work on a trip to the Rocky Mountains with Paul Scherer and Caryl Haskins.[157] Bush later said of the trip that "it would have been very enjoyable, except that my headaches didn't leave me . . . I came back from the trip pretty well convinced that the headaches weren't just a matter of having been overtired."[158] His mental condition was so poor that he was even incorrectly diagnosed with a brain tumor.[159] After the diagnosis was dismissed, Bush relayed his recent health struggles to Robert Loeb, his physician. The doctor's advice was "don't ever get into a situation as you were in Washington, and don't get into the government service again." Bush had fought vigorously to remain in control of American science, but finally had to accept that his wartime position at the helm of leadership in government

153. Reel 3-A OHI, MIT Archives VB MSS, MC-0143, Box 1.
154. Zachary, *Endless Frontier* (ref. 6), 281.
155. Reel 3-A MIT Archives VB MSS (ref. 154).
156. Ibid.
157. Ibid.
158. Ibid.
159. Ibid; Zachary, *Endless Frontier* (ref. 6), 342.

would never return. His psychological turmoil was so great as to express itself in serious physical ailments.

Even amidst the long-delayed creation of the NSF in 1950, the years following Bush's departure saw a continuation of the trend of increased military control in research, especially in the physical sciences. At the time of the NSF's establishment, Lee DuBridge remarked that it was a necessary step against the serious "danger of [science] becoming a stepchild of military technology."[160] Forman argued this concern was realized in the immediate postwar period, writing that "through the 1950s, the only significant sources of funds for academic physics research in the U.S. were the Department of Defense and an Atomic Energy Commission whose mission was *de facto* predominantly military."[161] Stuart Leslie expanded on this interpretation, writing that military technology "virtually redefined what it meant to be a scientist or engineer—a knowledge of microwave electronics and radar systems rather than alternating current theory . . . of nuclear reactors, rather [than] Van de Graaff generators."[162] At Stanford, ONR grants were secured by establishing research in microwave electronics, traveling-wave tubes, and other physics research relevant to national security.[163]

Although the emergence of the military as a patron of science was a significant shift from Bush's wartime administration, it is important to note that military dominance of funding was not necessarily absolute or permanent. Far more military influence was present in the physical sciences than other disciplines. The biomedical sciences, for example, continued to receive considerable funding from a variety of private and public institutions, most of which were primarily civilian-led.[164] Even in the physical sciences, military control did not remain as strong as it was immediately following Bush's postwar fall. Particularly after the 1957 Sputnik launch, weaker advisory groups like the Office of Defense Mobilization's Scientific Advisory Committee were replaced by the more robust President's Science Advisory Committee.[165] The creation

160. Robert P. McCune, "Origins and Development of the National Science Foundation and Its Division of Social Sciences, 1945–1961" (unpublished manuscript, 1971), 156, quoted in Kevles, *The Physicists* (ref. 93), 358.

161. Forman, "Behind Quantum Electronics" (ref. 26), 194.

162. Leslie, *Cold War American Science* (ref. 5), 9.

163. Leslie, "Playing the Education Game" (ref. 25), 68–70.

164. Hunter Heyck, *Age of System: Understanding the Development of Modern Social Science* (Baltimore, MD: Johns Hopkins University Press, 2015), 64–80; Kevles, *The Physicists* (ref. 93), 148–51, 185–99; Solovey, *Social Science for What* (ref. 112), 100–06.

165. Z. Wang, *In Sputnik's Shadow* (ref. 86), 86, 87.

of NASA one year later would mark another increase in civilian involvement of science policy, as groups like the Army Ballistic Missile Agency were incorporated into the space agency.[166] However, gone were the days of Bush's near-complete civilian administration of science policy and limited military interference.

Military patronage in Cold War science policy, particularly in the physical sciences, did not necessarily mean scientific inquiry became entirely focused upon national security—the ONR provided ample funding for basic research that was only vaguely connected to national security, a role which would be curbed much later in the Mansfield Amendment enacted in the 1970s.[167] However, this wide scope of military involvement serves to further demonstrate the fundamental shift in leadership occurring in the early postwar years. Bush's departure from Washington marked both the end of independent civilian direction of research and the transition from personal to institutional decision-making on science policy.

ACKNOWLEDGEMENTS

166. Ibid., 97; Charles Benson and William Faherty, *Moonport: A History of Apollo Launch Facilities and Operations* (Washington, DC: NASA Scientific and Technical Information Office, 1978), 17–20.

167. Kevles, "Cold War and Hot Physics" (ref. 26), 263–64; Sapolsky, *History of the ONR* (ref. 5), 73–77.