Abstract

This dissertation, titled “The Rocket’s Red Glare: Global Power and the Rise of American State Technology, 1940-1960,” makes three distinct but interlocking historical interventions. First, it argues that the rise of technology as a central ideological component of global hegemony represents a historical contingency, rather than a reflexive characteristic of great power status. Second, it argues that the United States lagged significantly behind other powers in pursuing state science and technology for much of the industrial era—rather, it was the technological, bureaucratic, and doctrinal tutelage of Great Britain during the Second World War that finally coaxed the American state into pursuing what would eventually become known as the military-industrial complex. Finally, it argues that U.S. inclination toward global hegemony was neither ‘present at the creation’ nor a reluctant assumption of responsibility in the aftermath of war, but rather represented a conscious doctrinal pivot, one informed in large part by the technological changes of the war. The British, eager to prop up their ally, had desperately thrust a number of key innovations into the uncertain hands of the American state, among them radar, jet engines, antibiotics, and the seeds of nuclear weaponry. They had also pressed their American partners to erect new institutions to accommodate further state research into technology—institutions that were previously wholly lacking in the United States. To a surprising degree, then, the military-industrial complex that defined the postwar American landscape represented a foreign import. The dissertation’s chapters follow this theme through the aftermath of Sputnik in 1957, documenting the rocky implantation of a technological vision of global hegemony.
into an ill-prepared American state, with the military ending up as the only organization at political liberty to realize the vision of a scientific ‘Endless Frontier.’ The way this ideology of hegemony became reified among American thinkers, policymakers, and the public sphere, as well as its projection abroad by the 1960s, came to redefine the pursuit of power among industrialized nations and blocs the world over, from the EEC to the PRC. As the project ultimately reveals, however, powerful nations’ current commitments to science and technology are in fact contingent products of a chaotic historical moment, rather than a natural outgrowth of states’ will to power.
Acknowledgements

One of the absolute joys of graduate school has been the opportunity to meet, work with, befriend, and learn from so many brilliant people.

I cannot possibly say enough about my advisor, Daniel Immerwahr. His incisiveness, wisdom, intellectual instincts, and boundless energy are matched only by his generosity. Year in and year out, I barged into his office unannounced; no matter how busy he was (and he always was), he never gave me anything less than full, warm attention, and usually a hearty dose of whatever intriguing history he had just been learning. We arrived at Northwestern together, and from the beginning Daniel gave me respect, autonomy, encouragement, and unconditional support. I hope that in the intervening years I have managed to give back even a fraction of the joy and edification that he has given to me.

My scholarly worldview also owes an enormous amount to Ken Alder. Meetings in Ken’s office always go long, which is the happy result of the many directions his sharp intellect, “catholic” interests, and affable nature take him. Teaching numerous classes with him and collecting droplets from his voluminous base of knowledge has been one of the joys of my academic career. Many, many thanks also to Deborah Cohen, who has her students’ interests unfailingly at heart, and who has always gone above and beyond to keep up with my activities, to organize workshops and meetings for my benefit, and to put me in touch with new people, to say nothing of the brilliant ideas and suggestions she has brought to my work. Thanks too to Kevin Boyle, who is always helpful, always welcoming, and who always thinks of an angle for my work that hadn’t occurred to me before.
Just interacting with the faculty and staff at Northwestern every day imparts knowledge and wisdom, and it while it would be impossible to fully acknowledge everybody, I would like to express special gratitude to Michael Allen, Henry Binford, Geraldo Cadava, Daniel Greene, Melissa Macauley, Harriet Lightman, Annerys Cano, Tricia Liu, and Jasmine Bomer.

Outside of Northwestern, I owe a debt of gratitude to the many interlocutors who generously offered their feedback, suggestions, and interest throughout my process of research and writing. Particular thanks go to Kate Epstein, who has been a razor-sharp and enthusiastic ally for several years; she has gone through my work with a fine-toothed comb, listened generously to my half-formed ideas, and made me a better historian. Thanks also to Pap Ndiaye, David Kaiser, John Krige, Jenifer Van Vleck, Sean Sayer, and David Edgerton. Thank you to Lino Camprubi and all of my co-authors from the 2018 Barcelona workshop for *De la Guerra Fría al Calentamiento Global: Estados Unidos, España y el Nuevo Orden Científico Mundial* for their feedback and interest. Thanks also to everyone who made comments and suggestions on my project in its nascent form at the 2016 University of Hong Kong Spring History Symposium, especially Priscilla Roberts and Jay Winter.

I would also like to recognize my former professors and colleagues in the Department of History at the University of Florida. Thanks in particular go to William Link, who managed to see some potential in a raw undergraduate and who was always more than generous with his time, support, and advice. Thanks also to Benjamin Wise, Paul Ortiz, and Jessica Taylor.

Graduate school, of course, would not have been the same—or maybe even possible—without the comradeship, ideas, and support of my fellow PhD students. Particular thanks go to my
“academic sister,” Alvita Akiboh. From reading my work, to standing on street corners into the wee hours, to forcing me to press “send” on emails, she has always been a source of strong opinions and stronger encouragement. It has been a pleasure to grow through this process side by side. My thanks to Kevin Baker, who has been a generous listener and source of suggestions across many late hours in the “dungeon,” squabbling about everything from the nature of technological change to how to capitalize “UNESCO;” my work is inordinately better for his input, if not for his curmudgeonly preferences. Much warm appreciation to Alexandra Thomas, whose tizzies consistently entertain; whose background makes her the only of my friends I can say things like “chidrul” to; and whose warm generosity knows no bounds, from shared work days, to access to her Stellas, to her uncanny sixth sense about when I’d forgotten my lunch yet again. Thanks to “academic little brothers” Dexter Fergie and Niko Letsos for reading my long chapters at our “advisory family dinners” and providing their feedback and good humor. Thanks also to Elsa De La Rosa, Yanqiu Zheng, Melanie Hall, Aram Sarkisian, Amanda Kleintop, Lucy Reeder, Myisha Eatmon, Leigh Soares, Vanda Rajcan, Caity Monroe, Joy Sales, Andy Baer, Mariah Hepworth, Melody Shum, Esther Ginestet, Aisha Valiulla, Beth Healey, and Sam Kling.

Thanks to the Northwestern’s Chabraja Center for Historical Studies, Department of History, and Graduate School, as well as the Lyndon B. Johnson Presidential Library for financial assistance for research and conference travel.
I am grateful to the archivists at the Library of Congress Manuscript Division, U.S. National Archives, United Kingdom National Archives, Lyndon B. Johnson Library, University of Illinois, and University of Miami, for their help, insight, and time.

Finally, the most appreciation of all—although there could never be a way to truly thank them enough—goes to my family. To my mother Anne, my father Ron, Ben, Emma, Jenny, Alan, Sue, Nana, Iain, Hugh, Mairi, and everybody else in this amazing and loving and hilarious collection of personalities scattered all over the world: thank you. Your love, belief, and support means more than you can ever know.
List of Acronyms

- AAAS: American Association for the Advancement of Science
- ACAST: UN Advisory Committee on the Application of Science and Technology to Development
- AEC: Atomic Energy Commission
- APC: Office of the Alien Property Custodian, U.S. Commerce Department
- ARPA: Advanced Research Projects Agency
- BATM: Admiralty Technical Mission (UK)
- BBRL: British Branch Rad Lab
- BCSO: British Central Scientific Office, later British Commonwealth Scientific Office
- CAA: Civil Aeronautics Administration (U.S. predecessor to Federal Aviation Administration)
- CERN: European Organization for Nuclear Research
- CIA: Central Intelligence Agency
- CIOS: Combined Intelligence Objectives Subcommittee
- CMR: OSRD’s Committee on Medical Research
- CNES: Centre National d’Etudes Spatiales (French space agency)
- CNRS: Centre National de la Recherche Scientifique (France)
- CONACYT: Consejo Nacional de Ciencia y Tecnología (Mexico)
- DSIR: Department of Scientific and Industrial Research (UK)
- ECA: Economic Cooperation Administration (administrator of the Marshall Plan)
- ESRO: European Space Research Organization (ESRO)

- EURATOM: European Atomic Energy Community (one of the longstanding ‘pillars’ of official European unification)

- FAO: Food and Agriculture Organization (UN)

- FBI: Federal Bureau of Investigation

- FCST: Federal Council for Science and Technology (U.S. executive branch coordinating body)

- FIAT: Field Information Agency, Technical

- GCHQ: Government Communications Headquarters (UK intelligence agency, founded 1919)

- GE: General Electric Company

- GEE: Royal Air Force navigation system used during World War II

- HUAC: House Un-American Activities Committee (U.S. Congress)

- IAEA: International Atomic Energy Agency

- ICAO: International Civil Aviation Organization (UN)

- ICBM: Intercontinental ballistic missile

- ICI: Imperial Chemical Industries (former British chemical company)

- ICSU: International Council of Scientific Unions

- IEEE: Institute of Electrical and Electronics Engineers

- IGY: International Geophysical Year (1957-58)

- LoC: Library of Congress, Washington, D.C.

- LORAN: Long-range navigation system developed during World War II
- MIT: Massachusetts Institute of Technology
- MITI: Ministry of International Trade and Industry (Japan)
- NACA: National Advisory Committee on Aeronautics (U.S. agency from 1915 to 1958)
- NARA: U.S. National Archives II, College Park, Maryland
- NAS: National Academy of Sciences
- NASA: National Aeronautics and Space Administration
- NATO: North Atlantic Treaty Organization
- NDEA: National Defense Education Act (1958)
- NDRC: National Defense Research Committee (U.S.)
- NRC: National Research Council (operates under the NAS; sometimes written as NAS-NRC)
- NRRL: Department of Agriculture’s North Regional Research Laboratory in Peoria, Illinois.
- NSB: National Science Board, controlling body of the National Science Foundation
- NSC: National Security Council
- NSF: National Science Foundation
- NYU: New York University
- OANAR: Office of the Assistant Naval Attaché for Research-London
- ODM: Office of Defense Mobilization (U.S.)
- OECD: Organisation for Economic Co-Operation and Development
- OEEC: Organization for European Economic Cooperation, predecessor of the OECD
- OLLA: Lend-Lease Administration (U.S.)
- ONI: Office of Naval Intelligence (U.S.)
- ONR: Office of Naval Research
- OOR: Office of Ordnance Research (U.S. Army, founded 1951)
- ORI: Office of Research and Inventions (U.S. Navy, predecessor to the Office of Naval Research)
- OSI: Office of Scientific Information (CIA)
- OSRD: Office of Scientific Research and Development
- OSS: Office of Strategic Services (U.S. intelligence agency during World War II)
- OST: Office of Science and Technology (U.S. executive branch planning body)
- PSAC: President’s Science Advisory Committee
- Radlab: Radiation Laboratory (wartime research facility at MIT)
- RBNS: Research Board for National Security (short-lived U.S. defense research body)
- RCA: Radio Corporation of America
- RDB: Research and Development Board (U.S. defense research body)
- S:EF: Science: The Endless Frontier, 1945 report by Vannevar Bush
- SAC: Science Advisory Committee (U.S. executive branch, precursor to PSAC)
- SAGE: Semi-Automatic Ground Environment (U.S. nuclear response and attack computer network)
- STS: Science and technology in society (academic subfield)
- TIIB: Technical Industrial Intelligence Branch
- TRE: Telecommunications Research Establishment (UK)
- UKNA: United Kingdom National Archives, Kew, London

- UN: United Nations


- USDA: U.S. Department of Agriculture

- WHO: World Health Organization (UN)

- WMO: World Meteorological Organization (UN)

- WPB: War Production Board (U.S.)
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Introduction

In the early morning hours of August 29, 1940, a man named E.G. Bowen stepped out of the Cumberland Hotel in Marylebone, London, and boarded a taxi for Euston Station. At his side was an ordinary, unremarkable solicitor’s deed box, which he had kept under his hotel room bed the night before. His taxi driver that morning insisted on strapping the box to the roof of the cab, and although this made Bowen uneasy, he had no time to argue—his train to the Liverpool docks was leaving at 8:30 a.m. Arriving at the station without incident, Bowen called a porter, but the eager young man swept his luggage—and the box—away so quickly that Bowen was forced to run to keep up. As unassuming as his black box looked, Bowen was determined not to let it out of his sight.

Boarding the train, Bowen found his reserved compartment to be empty, with all the blinds drawn. Setting the box on the luggage rack, he took a seat alone, but was soon joined by a mysterious man. Well-dressed and slender, the man sat down in the dim compartment, scarcely glancing in Bowen’s direction, and began to read the morning’s Times. The two strangers remained silent for the entire journey, except once, when a group of oblivious young men attempted to sit in the compartment. Without hesitating, the strange man jumped up and forcefully ejected them. Bowen began to suspect that he was not the only passenger on board concerned about his deed box.

Arriving in Liverpool, both Bowen and his anonymous companion wordlessly remained in their compartment until after the other passengers had disembarked. But the silence was soon broken.
Sensing a sudden commotion, Bowen wheeled around to see a dozen heavily armed British soldiers storm through the compartment door, remove his black box from the luggage rack, and cart it away. With a small nod, the thin man promptly folded up his newspaper and departed with them. This left Bowen—doubtlessly relieved after a bewildering morning—to head to the gangway of the Duchess of Richmond, bound for Halifax.¹

E.G. “Taffy” Bowen was one of Great Britain’s leading experts on radar, and his concern for the black box is understandable. In blueprints, manuals, circuit diagrams, films, prototypes, and samples, the box contained the British government’s most important, priceless, and top-secret scientific and technological breakthroughs. And Bowen was on a mission to give it all away to the United States.

But Bowen was no secret agent or saboteur. His mission was official, authorized by the Prime Minister himself. War-wrecked and desperate, the members of Winston Churchill’s cabinet wagered that freely giving away Britain’s most precious secrets might tempt the U.S. into alliance. They also hoped that the potent American industrial machine might mass-produce their world-leading technologies, thus helping them to survive the Nazi onslaught. What they could not have foreseen, however, was that the giveaway was to unleash a series of events that would permanently rearrange the American state—and profoundly transform perceptions of world power in the twentieth century.

Why would Americans need technological gifts from Britain? After all, the United States started the war as the world’s unquestioned industrial leader and, over the course of the conflict, revealed itself to be a master of astonishing new technologies. The surprise drama of radar, penicillin, and atomic bombs merely underscored what many already had come to understand: It had been a technological war, and U.S. technology had won it. Americans at the time had little doubt that Yankee ingenuity had, as one observer told it, “by far outstripped the rest of the world in genius and technological development.”2 This technological prowess was, in fact, a large part of why the United States was now recognized as the world’s leading superpower.

The technologies of victory continued to undergird U.S. hegemony in the years after the war. It was, after all, largely through hydrogen bombs, U-2 planes, satellites, and computers that the American leviathan sought to sustain a U.S.-centered order in the Cold War. And billions of dollars of outlays for scientific research made it clear that further technologies of superpower were expected in the future. Technology thus not only enabled U.S. global hegemony, it defined it. As John F. Kennedy declared, “This country rode the first waves of the industrial revolutions, the first waves of modern invention, and the first wave of nuclear power, and this generation does not intend to founder in the backwash of the coming age of space. We mean to be a part of it—we mean to lead it.”3

Shockwaves set off by this new, American conception of hegemony meant that by the 1960s, global power politics came to be defined by an alphabet soup of CERNs and NASAs and NSFs and

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MITIs and CONACYTs and OECDs; it came to be illustrated by the grainy images of moon landings and the crackling sound of satellite pings and the thundering din of supersonic aircraft. National governments and even whole regional blocs invested untold resources in building up their own technological commands, all to chase the U.S. lead. The global balance of power came to be measured in large part by which country held the most advanced technologies.

It is surprising, then, that when we take another look at the history of the United States, we realize that American policymakers did not always think in these terms—far from it. In fact, prior to 1940 the U.S. state was both deficient in the sorts of command technologies developed by rival governments for their own projections of power, and lacking the will and effective bureaucratic mechanisms to acquire and deploy them. The technological world order of the Cold War, it turns out, represented a contingent historical phenomenon—one whose causal roots we can trace.

Although it is easy to assume that advanced technology is an inherent attribute of modern hegemony, it is not. In fact, what defines global power is a historical question, one that has been answered differently at different times and places. Are great powers great because of their territorial extent, large populations, productive capacity, elevated morals, or refined high culture? All have been important metrics in the superpower footrace at one time or another. In the same way, the identification of world-power status with high technology is a historical artifact, one that is largely a product of the Second World War.

This is not to say that the United States in 1940 was not already a world power in myriad ways, nor that its citizens lived lives devoid of advanced technology. The industrial capacity,
economic output, raw materials, labor reserves, purchasing power, and production lines of the U.S. remained internationally unparalleled. And the inventiveness and commercial success of U.S. industrial laboratories were on par with the world’s most advanced economies. But the fact remained that the American government—constrained by ideological quarrels over its place in the world and the proper role of the state—lagged behind its economy in exercising global clout. As a result, one of the areas that slipped through the political cracks was a centralized state command of science and technology.

In the civilian world, America’s primary exponents of research and development had long been philanthropic foundations, corporations, and the National Academy of Sciences, a nongovernmental honor society run largely by anti-statist elites. In the military realm, convention still dictated R&D mainly to be the province of private industry, reimbursed only by purchasing those devices that might be developed and manufactured by companies. On the eve of the war, the American state put substantially more funds into agricultural R&D than military technology.

This was part and parcel of an overall laxity in the country’s security stance. Bounded by what C. Vann Woodward called geographic “free security” and disengaged from the globalized tensions that defined the interwar period, the United States in 1939 maintained an army the size of Bulgaria’s.

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6 C. Vann Woodward, *The Future of the Past* (New York: Oxford University Press, 1989), 109; George C. Marshall, *Biennial Reports of the Chief of Staff of the United States Army to the Secretary of War, 1 July 1939-30 June 1945*
Its oceanic security still contentedly relied on the infrastructural power of the Royal Navy; no one thought twice, for example, when President Roosevelt, in his famous Arsenal of Democracy speech, asked the public, “Does anyone seriously believe that we need to fear attack anywhere in the Americas while a free Britain remains our most powerful naval neighbor in the Atlantic?” In such a context, the U.S. government remained relatively indifferent to the strategic, material, and geopolitical importance of state-driven science and technology.

This was in sharp contrast to the other industrialized powers of the prewar period. Great Britain, in particular, firmly considered itself a technological hegemon. Like Germany, France, the Soviet Union, and Japan, Britain had spent the previous half-century nurturing a sophisticated bureaucracy dedicated to research and development. At home, it operated a sprawling complex of laboratories, institutes, and collaborative research associations, supporting a range of R&D interests in both basic science and strategic technology. Abroad, its telecommunications systems, air power, and modern navy allowed it to command the global commons nearly unchallenged, despite the imminent deterioration of its empire. In fact, such deterioration only inspired its commitment to research, since the race to develop and wield new innovations seemed to assure power, security, and influence in global affairs. Thus, to Britain—just as to almost all its industrialized peers—state

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technology represented an indispensable marker of geopolitical standing. It follows, then, that only true desperation could have driven decisionmakers in Whitehall to give Britain’s most treasured scientific and technological secrets away to the United States.

When we consider the prewar disparity between Britain and the United States, and when we put that disparity in the context of what U.S.-centric hegemony came to look like in the decades that followed, Bowen’s journey that day in 1940 begins to take on an extraordinary historical significance. Britain, as it turned out, was not just offering the United States its technological secrets or bureaucratic know-how. Consciously or not, it was passing a hegemonic baton to the world’s next superpower.

This dissertation is about global power; it’s about technology; and it’s about the ways in which hegemonic ideas get embedded in processes of statebuilding. It begins with a seemingly simple story of technology transfer. Bowen’s journey—part of a broader exchange program known as the Tizard Mission, after its leader, Sir Henry Tizard—provided the United States with new scientific knowledge of momentous strategic and symbolic importance to the war. British research and collaboration helped catalyze U.S. development of radar, sonar, penicillin, jet engines, supersonic aerodynamics, and the atomic bomb, among others. That powerful cache of innovations became the foundation upon which further hegemonic technologies emerged in the coming years, including commercial and military aviation; intercontinental missiles; hydrogen bombs; satellite communications; and world-leading pharmaceuticals.
But as this dissertation will show, the technologies of the exchange were not just important in and of themselves. Their significance also lay in the new organizational forms that they galvanized, and the cascading effects upon Americans’ conceptions of themselves and their power that they engendered. Arriving in Washington and finding an unexpected bureaucratic vacuum for science and technology, the British pressed their American partners to erect new institutions for accelerating research and development. When they did so, they found an eager group of ideological allies—American scientific thinkers and organizational theorists; receptive young researchers and military officers; administrators and politicians long frustrated with the status quo of U.S. research and development; and people newly seduced by the sublime power and possibility that the British technologies seemed to promise. Together, these transatlantic compatriots fashioned new bureaucratic arrangements for technoscience, conjured new roles for the American state, and introduced new people and voices into the U.S. diplomatic and policymaking machinery. In the twenty years that followed, the same cohort of Americans—people who were present for the British exchange, people who collaborated with them in both research and statebuilding, and people who were electrified by the resulting projects and institutions—permeated U.S. government and military establishments, relentlessly pressing their vision upon a state that was often unready for its new international responsibilities and sweeping global role.

I call this group the Tizard Generation. They were scientists, politicians, military officers, and lay fellow travelers possessed of a burgeoning vision in which the future diplomacy, security, economy, military, and capacity for world leadership of the United States would be measured by the
extent to which the country could occupy the vanguard of human knowledge and wield radical new technologies. And while the desire for beneficial new innovations—an unprecedented bomb, materials to aid human endurance and productivity, medicines to stave off death and dismemberment—were universal, the Tizard Generation went further. Their strain of thinking was what we might call a future-oriented technological globalism—an expansive prophecy in which science and technology would unlock new ways to manage the world and bend it toward U.S. interests. This was a new kind of potency that went beyond mere weapons stockpiling and tit-for-tat cycles of invention and reinvention.

These notions would require a new role for government: the war had taught the Tizard Generation that only the state could support such an ambitious program, and they pushed for its expansion. Moreover, they believed and disseminated the axiom—analyzed exhaustively by scholars since—that science represented an “endless frontier” that, if nurtured, would produce the technological and hegemonic results they sought. But this went beyond a mere ‘social contract for

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science’ or taxpayer support of academic interest groups. This was a futuristic vision both unique in its breadth and striking in its totality.

First, it was broad. For the vision to be effectively realized, the state would have to become interested in nearly all fields of human knowledge, from nuclear science to bathymetry. This was a remarkable ask for a government that had long relied on European science and the initiative of private corporations, but it was part and parcel of the sprawling new doctrine. As Alan Waterman, one of the prominent exponents of the ideology, argued, an unbounded commitment to broad progress in science was “an absolute necessity. In the modern world, science and industry are indispensable—for prosperity and leadership in time of peace, and defense in time of war.”


It was also global. Technological hegemony meant command of the global commons—not just ruling the waves, as the Royal Navy had done—but accessing and exploiting global space in three dimensions, eventually to include space under the sea and beyond the atmosphere. Such a command defined the technology of superpower. Technological globalism meshed directly with the emergent ideology of ‘nationalist globalism,’ which held U.S. interests to be the world’s interests. Indeed, it helped to lubricate that ideology’s ideals: The ability and right of the United States to go anywhere, the eschewal of formal empire, and the attempted projection of unlimited influence across a singular earth.11 New initiatives in research and development would henceforth be viewed for their global

characteristics, and for their value to the prestige, power, and hegemony of the nation. Indeed, many of the areas in which the U.S. sought to exert new technoscientific leadership—astronomy, oceanography, meteorology, nutrition, biomedicine, and atmospheric science among them—were universal in scope and perceived as such at the time, which was precisely why American leaders took an interest in them.\textsuperscript{12}

It is important to note that for much of this period, no studies or hard data existed to connect technology to national power, in economic terms or otherwise. Not until the late 1950s did rigorous study of R&D as a function of development and economic change begin to emerge, and even then it would be years before complex questioning of private and public flows of knowledge, intellectual property, administrative know-how, and national systems of innovation would reach maturity.\textsuperscript{13}

Policy thinkers’ assumptions about science and technology during this crucial period of American statebuilding, then, were inherently anecdotal, and the war and the British exchange taught the “anti-conquest” ideology; see John Fousek, To Lead the Free World: American Nationalism & the Cultural Roots of the Cold War (Chapel Hill: University of North Carolina Press, 2000).

\textsuperscript{12} Address, Alan Waterman, “International Aspects of Science,” University of Louisville, July 30, 1962, box 45, Alan Waterman papers, LoC.

Tizard Generation all it needed to know. Science—as long as a broad enough frontier of it was maintained—seemed to flow naturally into technology, because leading scientists believed it did, and because the Second World War had proved it. The Nazis had all but abandoned basic science in 1940, that was part of why they lost; the Allies doubled down and got penicillin, the bomb, and world leadership.14 That was seductive logic.

And convincing, too. From indifferent, horse-drawn beginnings, scientists and engineers working at the behest of the U.S. state—and especially its military—came to produce a breathtaking range of new knowledge and innovations, a number of which didn’t even seem to carry immediate strategic or economic value beyond the geopolitical prestige of commanding the scientific frontier. The application of enormous resources, systems thinking, economies of scale, and centralized coordination fueled the fetishization of expertise.15 By the 1960s, science moved to the center of a new, universalizing language of foreign relations and aid—a concurrence that combined political alliance, economic and social reform, and knowledge production and transfer, into a new package of R&D-based promises that seemed to harbor potential to solve the Cold War, global poverty, and resistance to American global interests in a single stroke.16 Above all, there were the technologies.

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Rockets, missiles, GPS navigation, synthetic lubricants, the internet, mainframes and personal computers, artificial intelligence, supersonic and hypersonic aircraft, large telescope arrays, particle accelerators, photovoltaic solar cells—it is a list that only scratches the surface of the tens of thousands of new devices, objects, and studies that the U.S. government either conducted or subsidized in this period, to say nothing of new scientific knowledge across a vast spectrum of fields, from meteorology to lepidoptery to human nutrition. The very foundations of postmodernity were churned out by these laboratories.

This is the world we still live in today, and because we interact with its trappings constantly, the relation between superpowerhood, Big Science, and High Technology seems natural to us. When we see China declare its intention to push the outer frontiers of pure science, to construct new national laboratories and accelerators, and to surpass the United States in R&D funding, we see nothing unexpected—China is a superpower, and science and technology is what superpowers do.17 As the case of the United States shows us, however, such a link is not automatic. The conflation of totalizing hegemony and futurist R&D—particularly at the scale, breadth, and ambition with which the United States conducted it—was something new in the mid-twentieth century. And because that conflation was not yet firmly in place in the minds of American policymakers at the start of the 1940s,

analyzing it helps us to historicize the evolution of notions of hegemony itself. Looking at technology not only allows us to see how the United States came to power, but also how the American ascendance changed what ‘coming to power’ meant.

Disentangling these concepts also helps us to locate the obscured origins of what we call the military-industrial complex, another aspect of U.S. hegemony that is often seen as preordained. In the years following the war, members of the Tizard Generation fanned out across the American state, attempting to infuse their beliefs about national power into new peacetime science foundations, foreign embassies, international development agencies, executive advisory positions, and the defense establishment. But the improvised and fraught nature of U.S. statebuilding in the early Cold War limited where and how they could promulgate their vision. In an increasingly dark and bellicose political landscape, the military turned out to be the only area of the state where they found the latitude, autonomy, and resources to piece together a comprehensive program. It was only after 1957, when the Soviet launch of Sputnik gave Americans a taste of the kind of existential technological dread that Britain had experienced a half-century earlier, that the cluster of institutions and ideas embedded in obscure pockets of the Defense Department moved to the mainstream. By then, the belief system linking knowledge, hegemony, and state organization had already been worked out and tested by the Tizard Generation, and the show was ready for the world stage.

Pulling on the seemingly simple historical thread of Bowen’s box, then, has much to reveal not only about the history of U.S. foreign relations, but about broader formulations of diplomacy and geostrategy in the twentieth and twenty-first centuries. It also helps us to look at the Cold War
militarization of American government and society in a new light. It is not my aim, however, to overestimate the role of the British in creating the U.S. techno-state. Nor do I use the phrase “Tizard Generation” with intention to lay a very complex series of historical changes at the feet of a single science adviser in Whitehall. Instead, I seek to recover a historical genealogy of people and principles, the tracing of which reconfigures our understanding of the postwar construction of the U.S. state and the building of Americans’ sense of their power in the world. It is my contention that only by looking at transnational flows of ideas—conceptions of power, strategies of diplomacy, models of statebuilding—and people—national leaders, bureaucrats, scientists, diplomats—can we fully understand the evolution of the U.S. state and its hegemonic designs after World War II. The British exchange was a spark; the implantation of new technoscientific institutions, ideologies, and people into the American state was a flame; and the domino effect in hegemonic thinking that followed set the whole world alight.

**Literature review**

Understanding the material and institutional origins of the American Century is important, but this is a matter of historiographical interest as well. Recognizing the quick transformation of the U.S. state from technological laggard to technological leader adds a neglected dimension to an emerging historical inquiry, one we might call the “hegemony question.” Scholars have long made one of two assumptions about U.S. world domination. Either they have believed that hegemonic thinking was present at creation—with the founders, from their remote perch in North America,
speaking eagerly of an empire for liberty—or they have assumed that it was reluctantly thrust upon
the United States during the Second World War after decades of isolationism, diplomatic hesitance,
and insularity.¹⁸ Recently, however, scholars such as John Thompson, Andrew Preston, Or
Rosenboim, and Stephen Wertheim have shattered those assumptions by showing how the U.S.
latterly came to see global hegemony as a rightful attribute, a conscious shift they date to the Second
World War. In a few short years, they argue, policy elites, public intellectuals, and others constructed
a new, all-encompassing vision of U.S. power, developing an inventive language of revived
internationalism (Wertheim), globalism (Rosenboim), and national security (Preston) to frame their
vision for the public and the world.¹⁹

These arguments center on the growth of diplomatic aspiration and capacity in the 1940s, but
the technological dimension to hegemony is also a crucial part of the story. U.S. global ambition was
not just a matter of grand strategy; it was also a matter of high technology, since technology (rather
than, say, large-scale colonization or the establishment of an enormous army) was one of the primary

¹⁸ For the former, see for example Walter L. Hixon, *The Myth of American Diplomacy: National Identity and U.S.
Foreign Policy* (New Haven, Conn.: Yale University Press, 2008); D.W. Meinig, *The Shaping of America: A
University Press, 1992); Anders Stephanson, *Manifest Destiny: American Expansion and the Empire of Right* (New
York: Hill and Wang, 1995). For the latter, see for example Geir Lundestad, “Empire by Invitation in the American

¹⁹ See John Thompson, *A Sense of Power: The Roots of America’s World Role* (Ithaca, N.Y.: Cornell University Press,
2015); Andrew Preston, “Monsters Everywhere: A Genealogy of National Security” *Diplomatic History* 38:3 (June
2014); Or Rosenboim, *The Emergence of Globalism: Visions of World Order in Britain and the United States, 1939-
tools the United States used to bolster its power. How and why the United States rose to hegemonic status, therefore, turns in large part on the question of how and why it came to care about technology.

As John Thompson puts it, in the post-World War II period, even domestic political divisions were inflected with a “high sense of America’s power and what it could potentially achieve. For, although the scale of American power resources did not in itself generate a will to meet the costs of deploying them strenuously, it did create a confident state of mind.”20 Building on Thompson’s work, I argue that the strain of nationalist globalism based on technological command—as formulated during and after the war by a different group of policy thinkers, the Tizard Generation—shored up that “sense of power” by creating a new sense of the possible and the necessary for U.S. global engagement. As Harry Truman noted in 1945, “We have the mass production and the know-how. Without us the rest of the world cannot recuperate; it cannot rebuild, feed, house, or clothe itself.”21

Wertheim suggests that the internationalist thinking of the prewar period had not incorporated world-encompassing organizations or global leadership, and that these aspects to U.S. hegemonic thought were late to arrive and consciously crafted. Building on this, I suggest that the new, future-oriented technological globalism of the Tizard Generation helped to enable a more ambitious diplomatic program for the country. This belief system was abstract and ideological, to be sure, but it also seemed to jibe with practical geopolitical strategy in the early postwar period. As Melvyn Leffler argued, at the beginning of the Cold War the U.S. took up the pursuit of a “preponderant influence in the international system,” seeking leadership in diplomatic, financial,

20 Thompson, A Sense of Power, 236.
21 Ibid.
strategic, military, and ideological world arenas. In the minds of a new and growing foreign policy elite, “power was determined by a country’s industrial infrastructure, technological prowess, natural resources, and skilled labor. If necessary, these material and human resources could be converted to military purposes.”\footnote{Melvyn Leffler, \textit{A Preponderance of Power: National Security, the Truman Administration, and the Cold War} (Palo Alto, Calif.: Stanford University Press, 1992), p. 496.} As technoscience champions within the U.S. state pieced together their vision of nationalist globalism, a robust R&D complex seemed to feed more and more into each of these strengths. Technology meant world-leading industry and “full wallets;” technology meant global free movement of U.S. interests and U.S. military power; technology meant infrastructural command; and technology validated the world-changing strength of democratic capitalism.\footnote{For “full wallets,” see Vannevar Bush, \textit{Science: The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research} (Washington, D.C.: U.S. GPO, July 1945).} A commitment to a broad program of state science and technology as envisioned by the Tizard Generation, in other words, would take giant strides toward securing each category of America’s preponderant global power. Technology was a means of global leverage.

Of course, what foreign policy elites and technoscience champions \textit{envisioned} and what activities and responsibilities the American state and public could and would bear were two different things. Historians and political scientists have developed a rich scholarship demarcating and debating the limitations of U.S. government mechanisms; the lengths policymakers had to go to court public opinion; and the strategies they used to pivot the state toward ambitious social and geopolitical
programs. These questions become all the more salient when considering the growing frictions between international and domestic policy in the late 1940s. Recently, James Sparrow and Mark Wilson have exposed the successes and capitulations of state actors in mobilizing the American public (Sparrow) and industry (Wilson) for national purposes during the war. This dissertation adds a transnational dimension to Wilson’s discussion in particular, showing in Chapter 2 that private corporations’ construction of a durable U.S. technological nationalism stemmed in part from their state-enabled co-optation of British R&D knowledge.

But this project is not only about the growth of the U.S. federal machinery. In connecting diplomatic strategy, statebuilding, and evolving hegemonic thought on one hand with the transatlantic circulation of scientific and technological knowledge, practices, artefacts, and people on the other, this project rests at the nexus of U.S. foreign relations history and the history of science and technology. Helpfully, the literature of science, technology, and society (STS) has long viewed World War II as a conscious point of rupture for the United States. Fusing the lessons of STS with foreign

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relations history thus helps us to construct a better understanding of the war and its ideological and institutional pivots.

STS scholarship detailing the war’s effects on the practice of science is voluminous and advanced. Early works in this vein concentrated on the academic world, particularly the physical sciences. A prominent debate on physics between Paul Forman and Daniel Kevles, for example, provoked an avalanche of scholarship about the effect of World War II, the Cold War, and militarization on academic science, often framed in terms of a Mephistophelean compromise between the corruption of state influence and the pursuit of “true” research. Sometimes, scientists themselves were interpreted as manipulating the state for their own purposes. This discussion was soon expanded to incorporate researchers’ complex roles in constructing the national security state; crafting a discourse of scientists-as-weapons; and establishing a politics of secrecy at midcentury. Standout studies by scholars like Paul Edwards and Joy Rohde have also revealed the dialectical processes by which machines, devices, and scientific knowledge influenced conceptions and

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languages of Cold War geopolitics itself—a process, as Edwards puts it, of “mutual orientation” between researchers and their patrons.28

To Edwards, “the new U.S. status as a superpower, the central role of science and technology in the war effort, the massive wartime federal funding and the associated advancement of communal aims for science, and other factors all contributed to the emergence of a powerful scientists’ lobby for continued federal sponsorship, on the one hand, and a wholly new sense within the armed forces of the importance of science and technology—and the potential contribution of ‘civilian’ scientists and engineers—on the other.”29 This dissertation adds further depth to this discussion by tracing the ways that the “lobby” promulgating ideas and ideologies originating in the wartime exchange with Britain came to embed itself in surprising locations in the state’s machinery—places like obscure corners of the Navy and State Department. But I also complicate the “mutual orientation” discussion, by demonstrating the ongoing difficulty the “lobby” met in translating its lofty ideas about science and technology to genuine political praxis. Far from a darkly militarized consensus firmly established by 1950, there was often little political will among military leadership, politicians, and bureaucrats to fulfill the designs of the interest group that had bestowed so many sublime technologies of superpower upon them.


In fact, it took nearly two decades of ardent proselytizing for the Tizard Generation’s vision of technoscientific foreign policy to move fully to the mainstream of U.S. foreign affairs. Bringing diplomatic history back into the discussion, we see an ongoing impulse at almost every level of American policymaking toward the implementation of “low-cost internationalism,” even with the advent of the all-embracing doctrine of containment. As Leffler wrote of the late 1940s, for example, “domestic considerations engendered the gap between means and ends. Americans wanted to bring their boys home, cut taxes, and focus on internal priorities. Truman wanted to achieve U.S. security objectives on the cheap … Ideally, he wanted others to bear the costs and undertake the policies that would prove compatible with American security needs.”

Paradoxically, as this project’s third and fourth chapters show, evolving views of U.S. science and technology both fed the sense that “low-cost” global leadership was possible, and tempted leaders and politicians not to invest fully in the Tizard Generation’s vision, at least not yet. Flashpoints like the Korean War did convince policy elites like Paul Nitze that science, technology, and systemization would need to replace national political will and resources, but ongoing discourses about innate American “know-how”, the supremacy of the industrial part of the military-industrial complex, and continued technological progress despite wavering state commitments to it, all militated against the kind of urgency that technoscience champions exhorted their leaders to adopt.

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While this dissertation contributes new scholarship to STS, it also draws from the field’s theoretical and empirical frameworks for its own framing. Scholars have moved beyond a laser-focus on Big Science and universities to promote a more complex and interdisciplinary understanding of what science and technology meant, and what it meant to the global Cold War. This understanding has expanded our field of view to include practices, relationships, and ideologies under the general rubric of “science” across a range of physical and intellectual spaces, from the hyperlocal to the global. And it has challenged us to think about the origins of engrained concepts like “technological innovation,” a discourse that Benoît Godin has traced to post-World War II stress on a totalizing concept of technoscience-as-application, rather than as simply accumulation of knowledge.32

These U.S.-centric studies on the practice of science have long run in parallel to a separate strain of studies on technology and empire. The oeuvre of Daniel Headrick, in particular, has illustrated the mutually reinforcing nature of industrial technology and Western imperialism, by noting the ways that technological advantages enable conquest, perpetuate underdevelopment and exploitation, and provide a “temptation to coerce” for imperial metropoles.33 In the same vein,

Michael Adas has argued that technological imbalances served to convince Europeans and U.S. Americans of their own cultural and moral superiority, a set of “technological imperatives” that informed paternalistic imperial justifications and undergirded civilizing missions. Scholars have also produced important work on the adaptations and resistances to imperial technology of colonial subjects and postcolonial actors. For its part, this project complicates discussions of imperial technology by highlighting the ways that metropolitan deployments of technology could be incoherent and haphazard, even as ideologies of superiority trickled into industrialized nations’ self-conceptions via their technological contexts.

STS has also paid increasing attention to international and transnational questions beyond the strictly imperial. As John Krige maintains, if the question “how does knowledge circulate?” forms the central question of the history of science, then the ways knowledge does or does not circulate in transnational, multinational, and global networks—particularly as science and technology itself enables, accelerates, and even impedes those flows—demands our attention as scholars.

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But these transnational flows do not diminish the importance of the nation-state to the story. The critical aspect of the Tizard Generation’s lobbying efforts for science resources was that, despite frequently incorporating paeans to scientific internationalism, their programs were nevertheless explicitly pitched as enabling a *nationalist* globalism—conducted in a globalist mode, that is, but by and for the state and its hegemonic designs. As Krige writes, “an analysis of knowledge-in-movement cannot ignore its value as a national resource. When national power and sovereignty are entangled with access to and control over knowledge in its multiple forms, and when scientific and technological prowess are markers of national achievement… states will affirm their right to regulate the circulation of knowledge.”37 As David Edgerton adds, techno-globalist accounts focused on transportation, communications, and infrastructural technologies that construct a borderless “global village” of flows ignore the ways that those technologies are often profoundly nationalizing, firmly accruing to the power projections of nation-states.38

Related to these discussions, STS has also developed the useful concepts of “technopolitics” and, still in nascent form, “technodiplomacy.” As Gabrielle Hecht has deployed it, technopolitics refers to the “strategic practice of designing or using technology to enact political goals. Such practices were not simply politics by another name; they produced systems whose design features mattered fundamentally to their success and shaped the ways in which those systems acted upon the

37 Ibid., 4.
world.” Scholars such as Krige and Mario Daniels have very recently extended this formulation to test the notion of “technodiplomacy,” in which the strategic sharing or withholding of knowledge—in the form of objects, practices, and “knowledgeable bodies”—becomes a defining factor in states’ relationships on the world stage. Technodiplomacy—as both a category and a framework for understanding intentions of historical actors and the limitations and blindesses in their worldviews—helps us better to account for midcentury U.S. ideology, diplomatic strategy, geopolitical failures, statebuilding, and global engagement, as well as the responses, negotiations, and adaptations to them by other states and actors. It does so by focusing on objects, people, and practices that are usually excluded from such studies in diplomatic history.

As Hecht, Martha Lampland, Ruth Oldenzeil, Peter Redfield, and others have demonstrated, moreover, technodiplomacy can also help us to interrogate the framework of the Cold War itself, by overturning its provincialism as a temporal and spatial category and even questioning its usefulness as a method of analysis. As this reframing alters our perspective of science and technology, technological nationalism, and the practices and flows of knowledge, we begin to see how changes in the material framework of technoscience affected historical actors’ views of the midcentury world. As David Kaiser puts it, “science during the Cold War became a much more international, even global,

39 Hecht, ed., Entangled Geographies, p. 3.
41 See Hecht, ed., Entangled Geographies.
endeavor; it became a more formalized and a more instrumentally oriented enterprise even as it was less structured by traditional disciplinary boundaries; it involved the development of new techniques and technologies for gathering, storing, representing, and modeling new data; and it became part of projects for remaking not only war but also the world, state, society, and self.”

Historians of U.S. foreign relations have already begun doing valuable work along these lines, even if not using STS terminology to describe it. Scholars like Kate Epstein, Jonathan Winkler, and Barry Posen have imbued studies of foreign relations with attention to questions of technological change, knowledge transfer, and infrastructural frictions in the global commons. In the history of the Cold War, they are joined by scholars including Krige, Jenifer Van Vleck, and Jeffrey Engel, whose works demonstrate the importance of hegemonic projection to technology history, in addition to the institutional and social constructions of knowledge and artefacts.

Finally, this project both draws on and contributes to STS scholarship about networks and flows of expertise. I contend that we must look to transnational flows of knowledge, objects, and institutional arrangements in order to understand the American rise to global power. The British exchange was important not just for its bestowal of the strategic benefits of commanding

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technologies like radar and penicillin, but in also for its assembly of people, organizational arrangements, and ideologies. Transatlantic scientists and administrators collaborated in organizational and intellectual spaces new to the history of the U.S. state, resulting not just in the creation of new modes of research and expertise, but also the production of new language about nationalism, technology, strategy, and hegemony. Scholars have recently begun combining Peter Galison’s concept of a “trading zone”—in which scientific subcultures interact and form hybrid discourses of mutual understanding—with the notion of “interactional expertise,” in which members of one subculture (the U.S., for our purposes) learn not only the scientific knowledge of another (that of Britain), but also its language and practices. Episodes like the creation of the Radiation Laboratory at MIT (outlined in Chapter 1) represent processes of “walking the talk” that create their own new, hybrid forms of practice.45 In the case of the U.S., I argue, this hybridization resulted in a diminishing awareness of where these new practices originated, a circumstance that fed the country’s sense of inherent technological supremacy—and, ultimately, its Thompsonesque “sense of power” in the world.

**Chapter summary**

The organization of this dissertation recovers the primacy of the British exchange and the war experience in the historical change that followed. It then accounts for political and institutional roads not taken, before finally documenting the path that the Tizard Generation’s ideas ultimately took to become a mainstream diplomatic ideology and to shape the military’s co-optation of the laboratory.

Chapter One, “The Promethean Ally,” documents the decision by Great Britain to use its world-leading cache of scientific and technological secrets as a diplomatic lever to attempt to coax the United States into alliance during World War II. Facing the threat of Nazi invasion, Britain dispatched an elite team of state, military, and academic officials (the so-called Tizard Mission) to give all of Britain’s secrets away to the U.S. The gambit worked, and the Americans not only came to Britain’s aid, but also gained new, intricate knowledge of sublime technologies that would become central to American material identity in the coming years—radar, penicillin, the jet engine, supersonic aerodynamics, electronics research, and even early knowledge on atomic weaponry. But the mission also laid bare America’s prewar laggardness in technology matters, as the British found a woefully inadequate R&D infrastructure in the U.S. for the development of their secrets. This chapter argues that Britain’s direct efforts to shape American state institutions, beginning with the foundation of MIT’s Radiation Laboratory, laid the bureaucratic groundwork for what would become the sprawling state R&D complex of the coming decades, as well as planted the ideological seeds of technological hegemony, by convening a new generation of U.S. technoscience thinkers and putting them in positions of crucial strategic importance to the war.
While Chapter One analyzes how the military, civilian state actors, and academics came to work together in WWII, Chapter Two, “Atlantic Amnesia,” tells an altogether less cooperative story—that of the mobilization of private industry. The Tizard Mission succeeded beyond its wildest dreams in ramping up American R&D for the Allied war effort, but the monster quickly outgrew its chains. The translation of British forms of science bureaucracy to the American context—and the time crunch of the early war years—engendered a large-scale disregard for checks and controls over the fruits of that research. This empowered U.S. corporations to hoard intellectual property and, in some cases, to bully policymakers and officials from both sides of the Atlantic into serving private-sector interests. The symbolic and discursive success of American industry’s part in winning the war ossified this state-industrial relationship as the Cold War dawned, thus solidifying and sustaining the enormous technology corporations of midcentury—as well as the U.S. conception of itself as a modern, technological world power whose laboratories could win even the largest of global wars. This outcome permanently subordinated Britain’s commercial competitiveness vis-a-vis its larger ally. This chapter uses the primary case study of penicillin, as well as brief looks at jet engines and supersonic aerodynamics, to explore American corporate co-optation of British innovations for both private and national purposes.

Chapters One and Two set the genealogy of U.S. technological globalism in motion in a threefold way: By showing the discursive, nationalistic power of the war’s technological artefacts; by introducing the historical actors who would form the core exponents of the ideology; and by accounting for the country’s new institutional arrangements for R&D. World War II thus
represented a crucial material and ideological pivot for the United States. As chapters Three and Four show, however, that pivot did not occur in the ways we often assume, nor as immediately as we might expect. The ideological and political efforts by the Tizard Generation, in fact, repeatedly collided in the coming two decades with persistent anti-statism, bureaucratic incapacity, lack of expertise, and political hesitance in committing to their ambitious program of technoscientific hegemony. Chapter Three lays out the domestic aspects of this circumstance, while Chapter Four details the international.

Chapter Three, “The Aimless Frontier” documents the surprising persistence of prewar state-scientific laggardness, even as the Cold War reached its early apogee in the 1950s. Historians often refer to the inflation of the American government apparatus in World War II as creating a new warfare state and inhibiting a return to prior political impulses, but as this chapter shows, the death throes of small-state ideology (and an indifference to state technology) were prolonged. Programs to absorb and Americanize Nazi R&D, for example, were co-opted by industrial interests. Conservative politicians repeatedly rolled back research initiatives and sought to decimate funding for the National Science Foundation. Promoters of state R&D worked feverishly throughout the 1950s to convince what they saw as a complacent and insufficiently-committed nation to the diplomatic and strategic importance of government science and technology, but before 1957 they often found their pleas falling on deaf ears.

Chapter Four, “Fits and Starts,” traces the ramifications of these domestic difficulties to the international arena, where new and ambitious foreign programs dreamed up by U.S. hegemonic thinkers clashed with the lack of a legacy of expertise and the ongoing incapacity of the state for R&D.
Plans for a sweeping State Department science attaché program to pursue active technodiplomacy in capitals the world over were hamstrung by lack of interest and resources from the State Department. The country's first state-directed foreign development program, Point Four, suffered from vagueness of mission, corporate co-optation, and a cynical reorientation toward the extraction of raw materials. These failures contextualize the chapter's final discussion, which analyzes the security restrictions put in place during the 1950s on international science interchange, constraints that scientists claimed were harmful to the national interest. While remaining agnostic on that question, the chapter argues that McCarthyite witch hunts and security paranoia surrounding R&D perversely demonstrated that technoscience had become a central and existential marker of national strength to most Americans. They simply disagreed about where it came from and how to safeguard it.

With this uncertain and uneven commitment to science and technology elsewhere in the American state, members of the Tizard Generation found an opportunity to put their designs into practice in the military. There, civilians and like-minded military officers worked ardentely (and largely anonymously) to crystallize the institutions and collaborations of the war, and paper over the inadequacies of postwar American R&D. Chapter Five, “The Light under the Bushel,” traces their efforts through the particular case study of the Office of Naval Research (ONR), which distributed enormous financial and material resources to universities for basic science (as opposed to military hardware). The ONR was lauded by civilian researchers as a progressive-minded safety net for American science in the difficult early postwar years, and was especially praised for its eschewal of secrecy provisions and intellectual obligations to the armed forces. The Navy simply assumed that if a
broad program of research at the frontiers of existing knowledge could be fostered, some fraction of the results could eventually benefit the military. It was partly this breadth of state activity that helped the U.S. later to project itself as a technological power, symbolically exploring the boundaries of nature from the ocean floor to the Moon by the 1960s. This chapter thus clicks the third category—the military—into the previous chapters’ narrative of the rise of the military-industrial-academic complex, while showing both that this complex was significantly more contingent than commonly assumed, and that progressive ideas about science and the state came to embed themselves in surprising places—like the military—as a result of persistent contradictions in the construction of American globalism.

Ultimately, then, the midcentury American state—and its new forms of research and development—took on a militaristic character not simply because the exigencies of the Cold War caused the immediate mushrooming of a national security state, but rather because the country faced its historically unprecedented moment of global expansion amid the weight of political pressures and bureaucratic hindrances that were longstanding and deeply engrained. Viewed in this light, the “mutual orientation” between technoscience and the military calls up unexpected questions about the persistence of anti-globalism and anti-statism in the U.S.; the exceptionalness of the New Deal; the totality of the Cold War as a shaping force in midcentury American society and politics; and the push-and-pull between domestic and international pressures, even for the century’s most omnipotent superpower. It also brings to light the critical importance of transnational flows of people and ideas.
in accounting for the U.S.’s pivot to global thinking, as well as the contingent nature of the technoscientific mode of hegemony we have come to know in our own lives.

Considering these questions, what is perhaps most surprising is the total way that the United States did deploy scientific internationalism and technodiplomacy as a primary foreign relations strategy after the launch of Sputnik. For a brief time, the country’s diplomatic program and its longstanding belief in innate Yankee ingenuity overlapped. But in the united, cohesive, state-driven technological hegemony the country projected—the sending of NASA astronauts on global goodwill tours, the development of supersonic airliners, the inauguration of scientific development collaborations in the Global South—it papered over the torturous path it had taken to get there. The prestige of technoscientific global power had not been an automatic position or innate gift—in fact, it had taken nearly two decades of advocacy and organizational and political trial-and-error, executed by a particular group promoting a particular vision of future-oriented technological globalism. That group—the Tizard Generation—had been doing so, in fact, since the arrival of a remarkable box of secrets from London in 1940.

We can think of the British exchange, then, as having had a butterfly effect on the contours of U.S. technoscience and hegemonic thinking, with its origins becoming obscured as its effects amplified over time. The new brand of technological hegemony in the U.S.—and, thanks to the global reactions that followed, of the world—can thus be traced back from moon shots and nuclear arms races, back through institutions and artefacts, back through people and “knowledgeable bodies,” to the uncertain first days of the Second World War. When we do such tracing, we grasp the fact that
hegemonic technology is a historical creation and not an ingrained expression of industrial capacity, territorial empire, or economic might. By treating global power and technological command as separate historical variables, we find the beginnings of a key marker of U.S. power projection in the mid-twentieth century, and, indeed, begin to better understand its unraveling.
Chapter 1: The Promethean Ally

I’d like to begin with two vignettes, one from Great Britain, one from the United States.

First the British. In 1903, a Foreign Office worker, of uncertain name but carrying the pseudonym Carruthers, set sail on a small vessel with a friend—one Mr. Davies—from the port of Flensburg. As they advanced around the hook of Denmark and southwestward toward the Frisian Islands, a German patrol boat, the *Blitz*, approached and cautioned them to leave the area. This was unusual, and stoked the two men’s suspicions that something ominous might be going on in this windswept stretch of the North Sea. They were soon presented with an opportunity to investigate further, as a “smothering, blinding fog” chanced to settle over the archipelago. The cover of mist allowed them to slink ashore onto the small island of Memmert. To their surprise, they found a flurry of activity underway there—channel dredging, rail construction, and a great infrastructural project across the tidal sands to link the barrier islands to the mainland. Their daunting encounter with the *Blitz* had been unexpected; this discovery was downright shocking. It wasn’t long before they connected the dots. Piecing together fragments of information, overheard conversations, and hints from their reconnaissance, Carruthers and Davies came to the sickening realization that Germany was both amassing a fleet and putting together an ingenious technological launching area to send its
army across the North Sea. Britain could be invaded by its powerful continental neighbor at any
moment.

There was no Carruthers, of course, nor a secret German plan to attack the British Isles. It
was fiction—the page-turning plot of *The Riddle of the Sands*, published by Irish writer Erskine
Childers in 1903. But this was no mere pulp entertainment. The book carried a foreword and
postscript hinting that it was based on reality. And its message was deadly serious, warning the
British public that “facts are facts; and a successful raid, such as that here sketched, if you will think
out its consequences, must appal [sic] the stoutest heart. It was checkmated, but others may be
conceived. In any case, we know the way in which they look at these things in Germany.”1 *The Riddle
of the Sands* flew off the bookshelves, and sparked an explosion of so-called 'Invasion Literature' that
foretold a vulnerable Britain falling prey to German bellicosity.2 Childers himself continued to
publish treatises on the inadequacy of the British military and the imminence of interimperial war in
Europe. The author was so highly regarded, in fact, that Winston Churchill, the First Lord of the
Admiralty, sought him out at the start of the First World War for intelligence debriefings on the
continent’s North Sea coastline. Churchill would also later claim that *The Riddle of the Sands* led to a

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2 See Thomas Hitchner, "Edwardian Spy Literature and the Ethos of Sportsmanship: The Sport of Spying," *English
Literature in Transition, 1880-1920* 53:4 (2010), 413-430; Michael Matin, “‘We Aren’t German Slaves Here, Thank
God’: Conrad’s Transposed Nationalism and British Literature of Espionage and Invasion,” *Journal of Modern
Literature* 21:2 (1997), 251-80; Matin, “The Creativity of War Planners: Armed Forces Professionals and the Pre-
1914 British Invasion-Scare Literature,” *English Literary History* 78:4 (2011); Cecil D. Eby, *The Road to Armageddon:
furious spate of new base construction by the Royal Navy. Whatever the impact of Childers’s tale, the real Britain was to be gripped with invasion anxiety for the next four decades.

Now for the American vignette, this one true. One of the most well-known episodes in the history of the Second World War is the submission of the so-called Einstein-Szilárd letter to President Franklin Roosevelt on August 2, 1939. With its grave warning that nuclear chain reactions were “almost certain [to be] achieved in the immediate future”—and its suggestion that the Third Reich might be the one to do it—this watershed document has often been interpreted as setting off its own kind of chain reaction, rousing American officials to action on the atomic bomb and leading directly to the creation of the Manhattan Project.

This common recounting, however, is rather far from the truth. For a start, economist Alexander Sachs, the man tasked to deliver the letter, was forced to wait more than two months before receiving an appointment with the preoccupied president. When Sachs finally did manage to raise the alarm, the action taken by Roosevelt and his deputies did little to meet the gravity of the threat. The White House authorized the head of the Bureau of Standards, Lyman Briggs, to put together an Advisory Committee on Uranium to study the problem—and when it met, it agreed to allocate the issue only $6,000. Even that small sum was fiercely opposed as exorbitant by several of the committee’s members.

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Despite clear evidence that Nazi Germany’s nuclear program was up and running, and despite the endorsement of renowned figures like Einstein and Szilárd, delays and red tape continued for nearly two more years. A series of committees and subcommittees were put together, and reports and counterreports were circulated and argued about. Gatherings came and went, but infrequently; Briggs’s committee often went months without meeting. Worse, when the British MAUD Committee—well ahead of the Americans in its work assessing the destructive power of nuclear fission—sent its dire findings to Washington, it heard nothing back at all. An alarmed British representative flew across the Atlantic to confront Briggs in person, but when he asked why the United States didn’t seem to be taking atomic bombs seriously, he was shocked to find that “this inarticulate and unimpressive man had put the reports in his safe and had not shown them to members of his committee.” Only the combination of Pearl Harbor and further frantic exhortation by British delegates managed to finally set the American program in sustained motion. The Manhattan Engineer District was finally established in August 1942, a full three years to the month after Einstein and Szilárd had sent their warning. The real marvel of Los Alamos wasn’t that it was successful; it was that it was successful on a massively abbreviated timescale after years of vacillation from the government.

Taken side by side, these two vignettes tell us much about the relative mindsets of the British and American governments on matters of security, power, and technology in the first half of the twentieth century. They show us existential anxiety in Britain, and untroubled complacency in the

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6 Ibid., p. 372.
7 Ibid., p. 426.
United States. Most importantly, they presage that something would have to change if it ever became necessary for the two countries—possessed as they were of wildly divergent views on preparedness and power—to band together in the face of a common enemy. Sure enough, the two paradigms did collide as the Second World War dawned, as a harried Britain pressed its American ally to assume the same sense of urgency in security and technology matters that it had.

By 1945, the totality of victory and the sublimity of atomic bombs, radar, penicillin, DDT, jet engines, and other amazing new innovations had made Americans forget their prewar laxity. Popular science writers envisioning a limitless scientific future wove breathless wartime narratives of “technicians liv[ing] with their hearts in their throats,” and of Americans giving “their last ounce of energy, wit, and ingenuity to the task of making us ready for war.”8 Journalists trumpeted the notion that the U.S. had “by far outstripped the rest of the world in genius and technological development,” and had mobilized a unique national skill and ingenuity to “fashion the weapons that ultimately spelled doom” to the Axis.9

In truth, however, these triumphalist discourses masked the reality that an ill-prepared American state had been actively pushed by a foreign government into the sublime scientific developments upon which the U.S. staked its postwar reputation. A number of the prestige technologies trumpeted as triumphs of Yankee achievement had considerable scientific foundations in the United Kingdom. Many of them, in fact, had been sent in nascent form across the Atlantic by

the British government in the autumn of 1940, free, with no strings attached. Most importantly, the vast, powerful research complex that spawned the famed Cold War partnership between government, industry, and science in the United States had actually been partly catalyzed and molded by these transnational pressures.

This chapter will explore how Britain—a global power committed to international competitiveness through research and development—used science and technology as a geopolitical lever to entice the United States into alliance, as well as how British technologies and bureaucratic models helped civilian state-science to become a politically viable enterprise in the U.S. for the first time. It is partly the tale of a transfer of objects and secrets, but more importantly, it is a story of hurried institutional change. The chain reaction unleashed by Britain’s transfer inspired new statebuilding in the United States of a character unheard of before 1940. It also welcomed a whole new generation of young technoscience thinkers into the orbit of the state—a group that would play a central role in the forging of the military-industrial complex in the decades afterwards.

It is difficult to imagine a world in which the American state was not in command of the most advanced technologies of our times. But if we reorient our gaze to look at the conditional and uneven way a relatively laggard United States became the foremost technological-statist power in world history, it quickly becomes clear that an integral aspect of twentieth-century American global dominance actually rested on the shaky foundations of exigency and serendipity.
Things left unstated

The astonishingly rapid mobilization of the Arsenal of Democracy makes it reasonable to assume that U.S. research and manufacturing institutions were ready and able to take on new roles in a paradigm of state-dominated R&D once the Second World War began. A glance at the prewar organization of American science and technology, however, shows us that in 1940 there existed few, if any, effective bureaucratic mechanisms for transforming civilian scientists into the “wizards” guiding a spectral midcentury warfare state, and that the government itself sorely lacked the institutional know-how to incubate any.10

For generations, American governmental science was much more Lewis and Clark than Leó Szilárd. The anti-history of U.S. state technology before 1940 is a long one, and here it can only be summarized. For much of its first century of existence, domestic politics remained saddled with a deep suspicion towards federal involvement in science and technology. American business interests licensed, emulated, and even smuggled manufacturing design and equipment from British textile cities like Manchester, while European immigrants possessing industrial knowledge served as key conduits of technology transfer to the U.S.11 Yet government efforts to promote indigenous modernization met constant opposition from powerful blocs of politicians in the Jeffersonian

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10 Perhaps illustratively of this point, President Eisenhower latterly came to call his science advisory staff “my wizards”—but only after spending most of his tenure in the White House exhibiting a “profound ambivalence” towards scientists in general, and alienating them by, for example, siding with McCarthyites in the witchhunt of Robert Oppenheimer. See Graeme Browning, “Unwanted Advice?” National Journal, May 18, 1991; and Zuoyue Wang, In Sputnik’s Shadow: The President’s Science Advisory Committee and Cold War America (Piscataway, N.J.: Rutgers University Press, 2009), 43–44.
tradition. Electoral victory after electoral victory founded on the specter of national “consolidation,”
as well as pitched battles and court challenges over federal appropriations, thwarted centralized
involvement in science and technology.\textsuperscript{12}

Prior to the First World War, the most intensive work in what might be called U.S. ‘state
science’ came in the form of survey mapping and agricultural experiment stations. The latter were
created with the Morrill Act of 1862 and subsequent amendments, which transferred federal parcels
to state governments for the creation of land-grant colleges. Further attempts at centralization of
science were rebuffed. Notably, a Congressional study commissioned by Senator W. B. Allison in
1884 was discouraged by Navy Secretary William Chandler, who spoke for many when he argued that
“it would be a most anomalous proceeding to erect as a governmental department a department of
science or of art.”\textsuperscript{13} Further studies in 1903 and 1908 met similar ends.

It is true, of course, that by the turn of the twentieth century the United States was emerging
as a world leader in industrial power and commercial innovation. As one editorial breathlessly
opined, “America holds the future, a future beside which the past dwindles into insignificance…
Yankee ingenuity and skill are tireless, and Yankee invention has its grasp upon some of the most
notable scientific achievements of the age.”\textsuperscript{14} As Leo Marx famously argued, the rise of mechanized
industry imbued the American public with a whiggish sense of national progress, as the machine and

\textsuperscript{12} John Lauritz Larson, \textit{Internal Improvement: National Public Works and the Promise of Popular Government in the
Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House
\textsuperscript{14} “America’s Destiny,” \textit{Los Angeles Times}, Mar 20, 1896.
its engineer came to be seen as unique products of American democracy. But as Marx also notes, such faith also whitewashed the European origins of the industrial order.\footnote{Leo Marx, \textit{The Machine in the Garden: Technology and the Pastoral Ideal in America} (New York: Oxford University Press, 2000), p. 204.}

On one hand, there \textit{had} been an American scramble for invention: the number of patents and the diversity of individuals seeking them doubled between the end of the Civil War and the turn of the century, and the country had steadily urbanized, industrialized, and come to wield unprecedented wealth and commercial power. But much of this change was based on advances in production technology, standardization and interchangeability, and corporate organization, which together allowed for unprecedented volumes of commercial output. This, in turn, increased the rapidity with which incremental technological improvements could be made—the evolutionary process, that is, of “building a better mousetrap.”\footnote{Bruce L. R. Smith, \textit{American Science Policy since World War II} (Washington, D.C.: Brookings Institution, 1990), pp. 16, 27. See also Alfred Chandler, \textit{The Visible Hand: The Managerial Revolution in American Business} (Cambridge, Mass.: Belknap, 1993).} True innovation remained largely applied and derivative, as most of the basic—and even much of the applied—science undergirding American industry was siphoned directly from Europe. As economist Carl Snyder fretted in 1902, the list of Americans who had done “genuine and distinguished work” in science was “all too brief.”\footnote{Carl Snyder, “America’s Inferior Position in the Scientific World,” \textit{The North American Review}, January 1902, 59.} And all the while, the U.S. government showed little interest in rectifying the disparity.

To grasp the lack of state presence in this arena, we need look no further than the standard funding paradigm used by entrepreneurs and inventors of the day: Independent researchers were obliged to seek wide public interest in their work in order to attract investors. Inveterate showman
Thomas Edison, for example, found it necessary to use newspaper publicity, exhibitions, and grand, appealing rhetoric to generate enthusiasm, since no funding could be expected from the government, military, or universities.18 Later, evolved commercial empires like DuPont, Bell Telephone, Westinghouse, and Edison’s General Electric took the funding of R&D in-house, fusing powerful commercial laboratories with enormous productive capabilities to put technologies like refrigeration, applied electricity, sound recording, and film photography on the mass market for the first time.19

Industrial growth notwithstanding, the American establishment for scientific research remained in a fledgling state compared to that of Europe. Indeed, until the latter decades of the nineteenth century, U.S. industry had little native academic science to draw from at all. The research university concept was a relatively new import, with Johns Hopkins, Stanford, and the University of Chicago only appearing after 1876.20 As the twentieth century dawned, American academics like Arthur G. Webster and Robert Millikan produced important scientific advances, but their institutions remained second-class in the eyes of many in the scholarly community. Science students preferred to study overseas whenever possible, since the consensus held that the best training could only be obtained in Europe.21 Scholars themselves measured success by the Europe-dominated Nobel Prize system and by their degree of acceptance from counterparts in Britain and Germany. The

pioneering work of American physicist Arthur H. Compton, for example, seemed to attain real prestige only when its quality was recognized among the hallowed laboratories of Cambridge University.²²

Unlike the German institutions they were founded to emulate, American research universities were hampered by lack of coordination and the absence of federal support. Fleeting government attempts to ramp up academic research during the First World War were haphazard, and ultimately did little more than demonstrate universities’ lack of management prowess in handling sponsored research.²³ For their part, most academics firmly believed that basic science was not the province of the government, and feared intrusion and political control.²⁴ This left them vulnerable to competition from booming industrial and private laboratories, as better salaries and living standards lured researchers to industry, and as patents and marketing put proprietary walls around new discoveries. By the 1920s, university administrators shared the view of Brown University’s graduate dean, who worried that science becoming “exceedingly good business” might render academia merely the “humble expository mechanism of the intellectual accomplishments of commercial enterprise.”²⁵

As the twentieth century rolled on and other nations’ governments expanded their state research bureaucracies, ongoing small-state ideology in the United States meant that many such functions fell to private philanthropic foundations to perform. The germs of Big Science in the U.S were almost entirely undergirded by these foundations, from Rockefeller’s construction of the pathbreaking Hale Telescope on Mount Palomar in California, to the Research Corporation’s backing of the first cyclotron, which won its inventor, Ernest Lawrence, the Nobel Prize. Most importantly, the Rockefeller Foundation launched a major program of National Research Fellowships in 1919, which incubated a generation of young scientists and paid for most of them to study in Europe. The International Education Board and Guggenheim Foundation quickly instituted fellowship programs of their own. These grants not only strengthened teaching and research at U.S. institutions like Berkeley and Harvard, but also catalyzed a transatlantic flow of scholarly knowledge and contacts, greatly accelerating the internationalization of science before World War II. It is no coincidence that the crème of the postwar scientific establishment, including many of the luminaries who would

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28 The Rockefeller Foundation also provided fellowships for Europeans, including bringing eminent scientists for lectures and visiting professorships in the United States. See Gerald Holton, The Advancement of Science and Its Burdens (New York: Cambridge University Press, 1986), 129.
become responsible for the midcentury transformation of American state R&D, received their early
cultivation from these transatlantic exchange programs.29

In the U.S., even the government’s own science advisory body was an NGO—and a neglected
one at that. Congress created the all-volunteer National Academy of Sciences (NAS) in 1863 to
provide occasional science advice upon request, but for the next fifty years the government actually
made very few such requests.30 As an independent honor society, the Academy’s expenses were met
not by the state, but primarily by the Carnegie and Rockefeller foundations, and Carnegie
constructed the NAS headquarters in Washington.31 Even an expansion of Academy activities during
the First World War—via the creation of the National Research Council (NRC)—continued to hinge
on private initiative, and was in any case quickly scaled back in the post-Armistice rush to dismantle
wartime bureaucracies.32 As one high-ranking Army general noted, as the interwar years passed,
“practically speaking, we didn’t know [the NAS-NRC] existed except once a year when they had a
meeting. When they had a meeting, they usually had somebody present a request for money.”33

29 Oral history interview, Dr. Paul M. Gross with E. Vernice Anderson, February 18, 1982, RG307, 4: NSF Historian
file, entry UP-UP-1; Stack 103, Row 37, Cpt 15, container 21, NARA; and Karl T. Compton, “The State of Science,”
Technology Review, May 1949, box 131, Vannevar Bush papers, LoC. Compton notes that the fellowship program
was “largely effective within a decade or two in raising the United States from a second-rate to a first-rate world
position in science.”
30 Atkinson and Blanpied, “Research Universities: Core of the US Science and Technology System.”
32 Ibid.; Smith, American Science Policy Since World War II, 31; and David Noble, America by Design: Science,
33 “Proceedings of Conference to Consider Needs for Post-War Research and Development for the Army and the
Navy,” April 26, 1944, Room 3601, Navy Department, Washington, D.C., RG298, stack 370, Coordinator of
Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
As the nation’s most prestigious exponent of science, the NAS was not only ineffective at promoting state R&D, it actually militated against it in favor of the “fruitful stream of private patronage” that prevailed in the period. This anti-statism started at the top—the NAS’s president, Frank Jewett, was also the head of Bell Telephone Laboratories, and considered any form of federal subsidy for academic research tantamount to making scientists the “intellectual slaves of the state.”

After Pearl Harbor, state technoscience champions would look back on this complacent mindset with anger. As decorated Navy captain Carroll L. Tyler furiously told Congress, the members of the NAS “have been perfectly satisfied to sit there, all wrapped up in their diplomas and their togas and their great mass of knowledge and say, ‘We know all these answers, but if you do not ask us we are not going to tell you; it is none of our business.’ Their actions are the actions of the people of the Civil War days and are a result of their irresponsible attitude.”

Even the New Deal did not considerably expand role of the state in science and technology matters. Like so many aspects of national life, science found itself positioned precisely at the fault line between the tectonic forces of President Roosevelt’s recovery initiatives and the momentum of laissez-faire ideology. In 1933, the NRC convinced New Deal administrators to let it form a Science Advisory Board to study the problem of centralizing and coordinating national science policy, but the

34 Oral history interview, J. Merton England with Charles F. Brown, NSF General Counsel, August 1, 1975, RG307, 4: NSF Historian file, entry UP-UP-1; RG307-Stack 103-Row 37-Cpt 15, container 44, NARA.
Board was shunned by many scientific elites, and when federal funding for it dried up, the Rockefeller Foundation was forced to inject it with emergency grants. The Board finally presented a report, “Put Science to Work: A National Program” in November 1934, but the National Industrial Recovery Act (and its primary administrator, Harold Ickes) had a mandate to put *people* to work, not spend funds on long-range abstractions like scientific research. The Board was allowed to expire, with little lasting legacy.

The New Deal also exposed long-simmering rifts between scientists themselves, a division that further thwarted growth in state science. It is here that we see the first rumblings of the sleeping giant that would become the Tizard Generation. The Science Advisory Board largely represented one political wing of scientists, embodied by its chairman, MIT president Karl Compton. Ordained with progressive ideas about elite expertise, and dedicated to New Deal ideas about the dormant potential of the state, scholars like Compton in these years began a decades-long push for science to be “put to work” in service of the nation, as well as for basic science to be seen as a resource to be nurtured and replenished. This clashed with a powerful conservative school of scientists, exemplified by scholars like Jewett, Robert Millikan, and George Hale, who courted private money for research, and who militated against any government involvement in science as a dangerous fetter to progress. Their

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political strength—together with their public eminence—led to a repeated thwarting of state initiatives for research before the war.\footnote{Memorandum, Lee Anna Embrey to Mr. W.A.W. Krebs, Jr., “Item for Legislative History,” April 29, 1952, box 173, Vannevar Bush papers, LoC. For more on anti-technology sentiments and politics of the 1930s, see Peter Kuznick, Beyond the Laboratory: Scientists as Political Activists in 1930s America (Chicago: University of Chicago Press, 1987).}

Priorities began to change as storm clouds gathered over Europe in the late 1930s. But as the White House searched for legal ways to circumvent the 1935 Neutrality Act, it did so at odds with a fierce current of anti-interventionist public opinion.\footnote{For Roosevelt’s stances on intervention between Munich and Pearl Harbor, see Barbara Farnham, Roosevelt and the Munich Crisis: A Study of Political Decision-Making (Princeton, N.J.: Princeton University Press, 1997) and David Reynolds, The Creation of the Anglo-American Alliance, 1937-41: A Study in Competitive Cooperation (Chapel Hill: University of North Carolina Press, 1981). For an interesting argument that FDR was increasingly favorable to war and began maneuvering to intentionally smooth public opinion for U.S. entry, see John Schuessler, “The Deception Dividend: FDR’s Undeclared War,” International Security vol. 34, no. 4 (Spring 2010), p. 133-165.} This was reflected in Congress, as in early 1939, when Joseph Ames, chairman of the National Advisory Committee on Aeronautics (NACA), requested funding to modernize the agency’s out-of-date Langley Laboratory and construct a second, smaller one. Ames’s request explicitly hinged on the worrying aeronautical advances being made by German scientists, but legislators balked at spending taxpayer money on new labs and quashed the bill. Only when Charles Lindbergh appeared to provide celebrity testimony on the Nazi menace was funding approved.\footnote{The second lab became the Ames Aeronautical Laboratory, in Santa Clara County, California. Remarks, Edward J. Robeson, Jr., “NACA 40th Anniversary,” House of Representatives, Congressional Record, April 14, 1955; and Elizabeth Muenger, Searching the Horizon: A History of Ames Research Center, 1940-1976 (Washington, D.C.: National Aeronautics and Space Administration, 1985), http://history.nasa.gov/SP-4304/ch1.htm}

While defense and security concerns justified science spending in Europe, the U.S. military establishment—perhaps the only arm of the American state we might expect to have nurtured a
comprehensive research complex—displayed a startling and explicit lack of commitment to science and innovation. Line officers and high-level civilians with no science interest and no responsibility for initiating weaponry improvements had final word on what got money and what did not, and habitually diverted what small R&D funding existed to procurement, production, and other unrelated activities.  

Bright young officers were discouraged from technical careers. In-house laboratories mostly devoted themselves to simple testing and incremental improvements of existing weapons. R&D was assumed to be the province of private industry, and the military generally didn’t even contract for it—the prevailing paradigm was to let corporations develop something, and then pay for it by purchasing the end products at full price. Technological development was scarcely linked to operational experience at all.

In one episode from 1938, the House of Representatives appropriated $15 million to the Navy for R&D, with a special emphasis on anti-submarine technology. The bill passed the House, but upon reaching the Senate, top Admirals went to the chamber to testify against the money, saying that such science was unnecessary, especially if it was to be performed by civilians. The Senate killed the bill, and when the United States first entered the war its shipping was, as one report put it, “crucified by

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42 Julius A. Furer, USN (Ret.), \textit{Administration of the Navy Department in World War II} (Washington: Department of the Navy, 1959), 760.


submarines.” For their part, most civilian scientists had scant interest in courting military attention, and almost never framed their work in terms of enhancing national security.

The most powerful evidence for a prewar dearth of R&D capacity in the armed services is the way that military leaders later themselves condemned their own prior complacency. At the end of the war, many admitted that there had simply been a lack of appreciation in the services for science and technology. The military mind, explained Captain Tyler, actually “resented the possibility of ‘interference’ by scientists in military affairs,” both because officers distrusted civilian ‘longhairs’ and because they felt modern science to be “too far removed from the practicabilities [sic] of the military arts.” Secretary of War Robert Patterson—who himself admitted to viewing scientists as “a strange


48 Memorandum, Rear Adm. H. G. Bowen to Rear Admiral T. D. Ruddock, USN, July 20, 1945, RG298, Office of Naval Research papers, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 24, NARA.

49 Capt. C.L. Tyler, USN, “The Relations Between the Military Services and Science in the National Security Program, (1945),” RG298, Office of Naval Research papers, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA. In another telling episode, Enrico Fermi and Leo Szilard approached the Navy in 1939 about the powerful possibilities of nuclear fission. They did little to impress Rear Admiral S.C. Hooper, head of Technical Operations, and only received a NRL grant of $1,500 for fission research. The NRL did, however, maintain a small program until superseded by the Manhattan Project; it was beset, however, by bureaucratic problems, competition, and lack of resources, and was eventually overshadowed by the Army’s program. Edward Teller remembered that they “did not succeed because there was no technically competent office in the Navy to consider such matters.” Indeed, Ronald Powaski argues that Szilard and Fermi decided to approach FDR only after seeing the ambivalent reception they received from the Navy. Ronald Powaski, *March to Armageddon: The United States and the Nuclear Arms Race, 1939 to the Present* (New York: Oxford University Press, 1987), 4; Joseph-James Ahern, “‘We Had the Hose Turned On Us!’: Ross Gunn and the Naval Research Laboratory’s Early Research into Nuclear Propulsion, 1939-1946,” *Historical Studies in the Physical and Biological Sciences*, 33:2
breed of cats”—illustrated this consternation to Congress by recounting an inspection visit he took to Fort Jackson a full year after hostilities had begun in Europe. To his embarrassment, upon arriving at the base he found a full complement of horse-drawn artillery playing a central strategic role, “going along the highway, and they were saying, ‘Giddap there, giddap there.’ That was terrible… That was pretty bad.” Only after the alarming defeat of France by Hitler’s industrialized forces did the U.S. Army—still reluctantly, in many corners—commit to full mechanization. An entire year of domestic trial-and-error war games followed (part of the so-called Louisiana Maneuvers), which were an essential investment if the military hoped to gain familiarity and experience into how a completely technology-reliant U.S. Army would operate in the future.

Thus, while still enjoying the sunshine of what C. Vann Woodward called geographic “free security” as storm clouds gathered over Europe, the U.S. government was late to grasp the true strategic, material, and geopolitical importance of science and technology relative to other industrialized states. Full technological mobilization would come only after United States found itself placed in direct contrast with another global power’s research accomplishments. And just such a contrast was about to arrive, in the form of a secret technical mission from Britain.

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Clash of techno-empires

And what of other global powers? The United States’s laissez-faire ideology, it turns out, was highly unusual among industrialized countries. In fact, the world of great powers outside the U.S in 1939 was a constellation of state-led bureaucracies for researching, developing, and wielding advanced science and technology. The positions of other empires—and they were all empires—in sea and air power, armaments, industrial innovations, medicine, agriculture, and other nationally important markers of power and progress, only intensified the drive to competitiveness and parity among metropoles. Indeed, by the time war broke out in Eurasia, interimperial technological competition was crescendoing to a pandemonium.

In France, for example, the publicly-funded Academy of Science had been in operation since 1666. From 1922 to 1938 research was marshalled by the new Office National des Recherches Scientifiques et Industrielles et des Inventions which, it was hoped, would be able to call on any publicly-funded scientist to undertake research deemed by the office to be vital to the country. As historian Harry Paul characterized it, “This was science in the public interest with a vengeance … What savant could resist the moral authority of a request in the public or national interest?” By the 1930s, the Third Republic—largely thanks to the efforts of Nobel laureate Jean Perrin—had begun to accelerate its state R&D activities. In the span of just a few years it inaugurated a Caisse Nationale de la Recherche Scientifique; established a High Council on Research to set national policy; created an Undersecretary of State for Research (first occupied by Irène Joliot-Curie); and, at the outbreak of

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war in 1939, scrambled to put together a National Center for Scientific Research (CNRS). In the face of the Nazi technological and industrial regime, France intended to join and win the “competition in the race for grey matter.”

France was no exception among industrialized states. Germany had twisted its Notgemeinschaft der Deutschen Wissenschaft (Emergency Association of German Science) to serve the R&D needs of the Nazi regime, turning from pseudoscientific ethnography to armaments as war approached. In the Soviet Union, science and technology had been a central preoccupation from the October Revolution on, and Moscow put significant ideological and material weight into its state-run hierarchy of research institutes and laboratories. Japan, meanwhile, had been obsessed with technological parity since the Meiji Restoration, first pursuing industrial and agricultural knowledge transfer from the U.S. and Europe, and then moving on to R&D as a planned bureaucratic priority in

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the 1920s. The countries that considered themselves to be great powers felt that centralized science and technology was an indispensable activity in remaining as such.

Nowhere was this truer than in Britain, still the world’s largest empire by almost every measure in the 1930s. The British state’s interests in research had carried a heavy international and geostrategic tilt for centuries, from the Royal Observatory’s emphasis on maritime navigation to the imperial science of the Royal Botanical Gardens at Kew. Maintaining empire had led the government to enforce monopolies on telegraph and radio technologies for strategic and economic purposes, while mobilizing enormous resources for public health schemes in India. The eventual assembly of a concentrated state research bureaucracy in the early twentieth century retained this acute international and imperial valence.

Although the British state had made growing commitments to public science in the Edwardian period, it was the First World War that spurred the creation in 1915 of a Department of Scientific and Industrial Research (DSIR), using state resources and personnel to direct science policy and provide project grants. In the coming years, the DSIR opened an array of government laboratories, including the Radio Research Station, Hydraulics Research Station, and National

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Engineering Laboratory. It also took over and expanded extant organizations from other agencies, notably the National Physical Laboratory. The Colonial Office, meanwhile, maintained its research focus with the creation of concentrated bureaus of agriculture, veterinary science, forestry, and medicine. Still elsewhere, Royal Charters were granted for a series of targeted Research Councils, including the Medical Research Council (1920) and Agricultural Research Council (1931), all of which provided resources, laboratories, and streamlined organization for academic and industrial research.

A recent turn in scholarship, led especially by David Edgerton, has shown that Britain in this period explicitly saw itself as a global power in an international race to develop military high technologies. The British state led the world in defense expenditure in the 1920s, and constructed entirely new bureaucratic forms of science-oriented mobilization. Within this, the military amassed a complex of what Edgerton calls ‘big research’ that equaled or surpassed the activities of private

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60 Historians of Britain have debated the depth of early-century policymakers’ commitments to science and technology, as well as the purported lack of British industrialists' appreciation for research. They have chronicled disagreements among elite scientists themselves on the validity of pursuing research for nationalist ends, especially among socialists like J.B.S. Haldane and J.D. Bernal. But while policymakers’ motivations and outlooks may have wildly diverged, there is little doubt that the interimperial war footing of early-twentieth century Europe had a marked effect on British administrators' views on military, industry, and science. See Sabine Clarke, “A Technocratic Imperial State? The Colonial Office and Scientific Research, 1940-1960,” *Twentieth Century British History* vol. 18, no. 4, January 2007, 453-480; Andrew Hull, “War of Words: The Public Science of the British Scientific Community and the Origins of the Department of Scientific and Industrial Research, 1914-16,” *British Journal for the History of Science* vol. 32 no. 4 (December 1999); more classic histories of the bureaucratic buildup include Roy MacLeod and Kay Andrews, “The Origins of the D.S.I.R.: Reflections on Ideas and Men, 1915-1916,” *Public Administration* vol. 48 no. 1 (March 1970); Ian Varcoe, ”Scientists, Government, and Organised Research in Great Britain, 1914-16: The Early History of the DSIR,” *Minerva* vol. 8, no. 2 (April 1970).
industrial laboratories, while incubating new generations of scientific leaders and civil servants.\textsuperscript{61} The race to develop and command new innovations had the two-fold benefit of assuring power, security, and influence in global affairs, while keeping Britain ahead of Germany in military terms.

In fact, the “liberal internationalism” espoused by British leaders in the 1930s masked a militantly anti-Nazi ideology that inspired considerable government investment in science, industry, and research. Far from disarming in the interwar years, Britain kept military-industrial spending at high levels. As Edgerton notes, “the ‘welfarness’ of British state spending did not return to 1930s levels until 1970.”\textsuperscript{62} The direct threat of being overwhelmed technologically by foreign aggressors pushed the state deeply into technological innovation.

German air power, for example, represented a mounting threat to Britain’s geographic advantage as an island, both strategically and psychologically. Episodes of hysteria erupted in 1909 and 1912 when rumors spread that zeppelins had overflown England under cover of darkness. These worries fed a strident British commitment to aviation from the 1910s on, with elites coming to


believe that progress could only be made through organized research directed and controlled by the government.63

Insofar as Britain harbored public anxieties of ‘declinism,’ then, these can be read as only stoking—rather than lamenting the loss of—state technological commitments. Just as The Riddle of the Sands prophesied, the evolution of Britain’s state research complex was largely an exercise in international positioning—an apprehensive competition, that is, against rival great powers possessing like-minded nationalist commitments to science and technology.

And as we will see, on the eve of the Second World War, most British officials had come to assume that the United States was another such power.

A not-so-special relationship

Given the nationalist and militaristic origins of this science complex, it may at first glance seem peculiar that Britain should be willing to share its achievements with a foreign country with which it had no formal alliance. And indeed, before 1939 its scientific relations with the United States were rocky and marked by mutual suspicion. Uncoordinated exchanges of military research that briefly arose during the First World War between Britain, France, and the U.S. quickly dissolved after the Armistice, and their militaries explicitly refused to cooperate or divulge information on key

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technologies like sonar. In high-tech sectors of private industry, British firms sued American producers using UK wartime patents, and American industry responded with calls for complex indemnity procedures in the unlikely event of any future sharing. Throughout, the British jealously guarded their national technologies—the existence of radar, for example, was not even revealed to Dominion governments until the spring of 1939, nearly half a decade after the first successful tests in Britain.

The looming threat of another war did little to mend this antipathy. In 1938, for example, simmering transatlantic animosities came to a boil over a new type of tachometric bombsight in the possession of the American military. Devised by Carl Norden, a private Dutch inventor working as a consultant for the U.S. Navy, the device allowed for unprecedented accuracy in high-altitude aerial bombardment, and Royal Air Force administrators coveted it greatly. American officials, however, repeatedly rebuffed British overtures to trade for the bombsight. Both Prime Minister Neville Chamberlain and his successor, Winston Churchill, made personal appeals to President Roosevelt for an exchange, but as the device had been ballyhooed in the American press and in Congress as a “subject of envy” for foreign nations, the president rejected the offers. Incensed, British officials like the Royal Navy’s Admiral Somerville vowed to resist any future Anglo-American collaboration.

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Whispers around Whitehall even hinted at Nazi collaboration, including from Churchill himself, who declared: “I am not in a hurry to give our secrets until the United States is much nearer to the war than she is now. I expect that anything given to the United States Services, in which there are necessarily so many Germans, goes pretty quickly to Berlin in times of peace.”

As these episodes reflect, frustration and distrust toward the United States was a mainstream view in the British government. But it was not entirely a unanimous one. Particularly after the fall of Poland and Britain’s entry into war, a different, unorthodox idea began to emerge, nurtured by a small faction of the science establishment. It was the radical suggestion, that is, that Britain explore the possibilities of an entirely free, open, and comprehensive exchange of technical information with America. The main proponent of this idea was Sir Henry Tizard, then the chief science adviser to the Air Ministry.

Educated in chemistry at Oxford and having served as a scientist for the Royal Flying Corps during World War I, Tizard forged a successful career as a top-level science administrator during the interwar years. In 1926 he was elected fellow of the Royal Society, and in 1927 he was awarded a CBE and appointed permanent secretary of the DSIR. Most importantly, in the mid-1930s he spearheaded and chaired the Committee for the Scientific Study of Air Defence, which catalyzed research into

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68 Minute, Winston Churchill to General Ismay, July 17, 1940. UKNA, PREM 3/475/1.
radar and developed it into the Chain Home shield system—a cutting-edge advancement that would prove crucial to victory in the Battle of Britain.69

Tizard was one of a small number of dissenters from Whitehall’s apprehensive conventional position on exchange with the United States. In 1939 he proposed sending a science attaché, the Royal Society’s Archibald Hill, to Washington in order to test U.S. interest in a potential exchange, as well as to stealthily gauge the state of American science. Still distrustful, the Air Ministry approved Hill’s mission only as a possible backdoor way to acquire the Norden bombsight. Hill journeyed in March 1940 for a program of meetings with American scientists, officials, and firms.70 Helping Tizard’s case, Hill reported back that despite previous animosities, Americans were generally eager to


70 Zimmerman, *Top Secret Exchange*, 53. The personality politics of Britain’s War Cabinet are largely beyond the scope of this chapter, but suffice it to say that proposals for exchange with the U.S. experienced an even harder path to acceptance than they might otherwise have had, because their chief proponent, Tizard, was rapidly losing Cabinet influence by 1940 due to internal power struggles. His main political nemesis was the severe Frederick Lindemann, later Lord Cherwell, who was a strong favorite of Churchill. In 1936, Lindemann had been embarrassingly removed from Tizard’s Committee on Air Defence due to clashes over radar policy, and so when he followed Churchill back to prominence in 1939-40 he quickly worked to undermine Tizard. Upon accession to power Churchill immediately reorganized the Air Ministry, which gutted it of much of its scientific activities; this essentially rendered Tizard (the ministry’s science adviser) irrelevant. Tizard began to be excluded from high-level meetings and was overruled on important policy matters, and in June 1940 resigned from his position. Lindemann, meanwhile, became the *de facto* Cabinet adviser on all technical matters for the remainder of the war, and Churchill trusted him nearly unquestioningly. (Note also that this was to prove controversial later on, as Lord Cherwell was at the center of decisions leading to the deliberate bombing of dense working-class civilian neighborhoods in Germany, as well as the diversion of Indian Ocean shipping to send Britain surplus grain while famine killed millions in India). C.P. Snow would later recount the Tizard-Lindemann episode as a parable of poor government through influence-seeking, calling it “the purest example possible of court politics.” See C.P. Snow, *Science and Government* (Cambridge, Mass.: Harvard College Press, 1960); Zimmerman, *Top Secret Exchange*, 64-68; Madhusree Mukerjee, “Lord Cherwell: Churchill’s Confidence Man,” HistoryNet, September 29, 2011, [http://www.historynet.com/](http://www.historynet.com/)lord-cherwell-churchills-confidence-man.htm. Also note that David Edgerton has critiqued the dependency of Second World War British science historiography on the stories of “SOME scientists and SOME scientific organizations”—like Tizard—who were important to and stoked interest in the academic left in subsequent decades. See Edgerton, *Warfare State*, 321.
help Britain’s cause. Obliquely referring to growing divisions in Whitehall between nationalist science officials like Frederick Lindemann (later Lord Cherwell) and Tizard, he wrote that it was now in fact only Britain’s “impudent assumption of superiority” that was preventing American support.⁷¹

More importantly, while in Washington, Hill joined forces with the influential Lord Lothian, British ambassador to the United States, who was engaged in a protracted campaign to draw the U.S. toward aid and alliance. Lothian saw the idea of a free scientific exchange as an ideal way to court the Americans into “closer liaison and sympathy.” Britain’s “present bargaining position,” Lothian wrote to Whitehall, was robust thanks to its technological head-start and growing war experience, and the Americans were sure to recognize this.⁷² These arguments—along with Hill’s reporting—slowly began changing minds in London. The military services, for example, began to realize that if Britain did not furnish the U.S. with its technical secrets, any equipment manufactured there on Britain’s behalf would be scientifically obsolete by the time it could be delivered.⁷³

Lingering doubts remained among some Cabinet members, but they were quickly overtaken by external events that shook what Hill had described as Britain’s “impudence” and drove officials to near-desperation. In rapid succession surrounding the Westminster leadership crisis of May 1940, Neville Chamberlain resigned and Churchill was installed as Prime Minister; Germany shocked the world by invading and defeating Belgium, the Netherlands, and France; Britain’s army evacuated

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⁷¹ In a private letter to Tizard, an angry Hill wrote that “we could get much more help in the U.S. and Canada if we were not so damnably sticky and unimaginative [underlined twice]. There is an intense eagerness to help which we do not exploit: (a) because we are such bloody asses, or (b) because we are so sure we can win without anybody’s help.” Clark, Tizard, 253.


from Dunkirk; and the Luftwaffe began concentrated aerial attacks on industrial targets in the British Isles. The War Cabinet divided over a negotiated surrender to Hitler, and Britain’s cash reserves dipped to dangerously low levels. It quickly became clear that exhausted resources and threatened production lines would henceforth prevent Britain’s world-leading cache of scientific advancements from transforming into a serviceable stockpile of war materiel.

As the nation’s outlook reached its nadir, officials’ stances and language toward scientific cooperation with the United States rapidly softened. First Lord of the Admiralty A.V. Alexander wrote to Churchill that “in the circumstances of our present situation I feel that we should do everything we can to show our good-will towards the United States of America. I think that the time has come when we might greatly influence the American attitude in the right direction by making them an unrestricted offer to pool technical information” and “to release secrets without constraint.”74 The Minister of Aircraft Production, Lord Beaverbrook, likewise wrote, “It is my considered opinion that we should give the Americans all of our secrets,” especially if would mean receiving American military supplies in return.75 Meanwhile, Lothian continued to press his case, cabling from Washington that “we are losing precious time,” and that failure to make the offer “only provides another argument for the defeatists who say that it is no use backing a lost cause.” Lothian acknowledged that the U.S. would likely get “the better bargain,” but urged that this be disregarded in view of Britain’s desperate circumstances.76

76 Telegram, Marquess of Lothian, Washington D.C., June 27, 1940. UKNA, PREM 3/475/1.
Ultimate authority to greenlight an exchange mission fell to Churchill, who vacillated on the issue out of frustration over American delays in sending aid and arms. But the sheer momentum of War Cabinet opinion—and the desperate straits the war effort was in—pushed him into reluctant agreement. A message was promptly sent to Washington on July 8 laying out the acquiescent British position in no uncertain terms: “It is not the wish of His Majesty’s Government,” it emphasized, “to make this proposal the subject of a bargain of any description. Rather do they wish, in order to show their readiness for the fullest cooperation, to be perfectly open with you and to give you full details of any equipment or devices in which you are interested without in any way pressing you beforehand to give specific undertakings on your side.” Lothian pleaded the case to the White House, and received instructions from London that a British mission could depart in as little as ten days’ time.77

Given the startling generosity of Britain’s terms—and, possibly, given his conjectures regarding their technological capabilities—President Roosevelt responded that he would be “glad if the special mission could come as soon as possible.” It was agreed by both sides to keep it secret to avoid both enemy intelligence and scrutiny from American isolationists, and indeed, early meetings even used the back entrance to the White House to deflect any press attention.78 Owing to his credentials and centrality to the idea of exchange—and, perhaps, given the friction his presence was causing in Whitehall as he fell out of favor with Churchill’s inner circle—Henry Tizard was selected

77 Aide-memoire, Sir Henry Tizard for Franklin Roosevelt, July 9, 1940, UKNA, AVIA 12/246; and Cypher telegram, Foreign Office to Marquess of Lothian (Washington), July 6, 1940, UKNA, PREM 3/475/1.
78 Telegram, Marquess of Lothian, Washington D.C., July 22, 1940, UKNA, PREM 3/475/1; Zimmerman, Top Secret Exchange, 95; and Clark, Tizard, 263.
to head the mission. Preparations immediately began for the largest voluntary transfer of secret technical information in history.

**Secrets, par avion**

On August 14, Tizard departed from Britain alone. So great was the Cabinet’s anxiousness to begin the exchange that, as soon as possible after Churchill gave approval, Tizard set off unaccompanied to lay the mission’s groundwork, with the rest of his technical delegation to join him later once full preparations could be completed. Bound for Montreal via Newfoundland aboard the BOAC flying boat *Clare*, Tizard’s plan was to liaise with top Canadian officials in Ottawa before proceeding by rail to Washington, D.C. There he would lay out the contours of the exchange and establish key contacts—including with Lothian, Naval Intelligence director Admiral W.S. Anderson, Navy Secretary Frank Knox, and, a few days later, Roosevelt himself.79

Back in the UK, the rest of the mission worked feverishly to assemble the nation’s most advanced technological secrets. Nothing was to be excluded. Using the Ministry of Supply’s headquarters at Savoy House as a base, they scoured laboratories and agencies for what E.G. “Taffy” Bowen described as “anything we could lay our hands on which gave a factual account of what was being done and what was projected.” This included the jet engine, proximity fuzes, radar, gyroscopic gunnery predictors, torpedoes, rockets, the astonishing new cavity magnetron, and even the so-called Frisch-Peierls Memorandum, which detailed for the first time the realistic possibility of creating

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atomic weaponry. To efficiently communicate these advancements to the Americans, the team collected scientific data through manuals, blueprints, diagrams, and even films. The most important of these were deposited into Bowen’s black deed box, with the rest comprising nine large crates of material to be shipped to America separately.80

Once assembly was complete, the delegation departed Liverpool on August 29. Tizard had agreed with the Cabinet to appoint a small, elite team comprised of top scientists and highly-placed military officers; this would imbue the mission with diplomatic cachet and help convince the Americans of Britain’s achievements and war experience. Brigadier F.C. Wallace and Group Captain F.L. Pearce represented the Army and Navy, respectively, and were to be the liaisons for war operations, sonar, anti-aircraft gunnery, and other combat technologies. Bowen, the Welsh physicist who had worked with Tizard from the beginning on the Chain Home system, was selected as the team’s microwave expert. A.E. Woodward-Nutt, an aviation research director in the Ministry of Aircraft Production and another veteran of the Committee on Air Defence, was selected as the mission’s secretary. And the distinguished Professor John Cockcroft, a nuclear physicist from Cambridge University’s Cavendish Laboratory and a key official in the Ministry of Supply, was to take charge of all matters pertaining to signals, communications, radar, and navigation. Reunited aboard the Duchess of Richmond, the exclusive team sailed for Halifax. Woodward-Nutt was

entrusted with Bowen’s deed box for the voyage. It was drilled with holes to prevent flotation; in the event of a U-Boat attack, it was to be thrown overboard and sunk.81

From the start both nations referred to the transfer as an “exchange,” but the British knew that secrets would largely be flowing from east to west across the Atlantic. Tizard acknowledged as much in his first planning meeting for the mission, but underscored that the object was largely to create goodwill. If the mission could draw the U.S. into closer cooperation with Britain, allow research on British innovations to continue in American labs unburdened by the Blitz, and produce the results in American factories for use in the UK, then the giveaway would be worthwhile. And if Britain could glean anything to add to its own research on radar and armaments—or even pry the Norden bombsight from American industry—then all the better.82

With these goals in mind, the mission’s first task upon arrival was to thaw American suspicions and build mutual trust and confidence. By that summer, many reliable American press outlets were depicting a London in ruins and forecasting a high probability of successful German occupation. Indeed, upon hearing one day’s particularly bleak news, Henry Tizard himself bet one of his mission colleagues five dollars that Britain would be invaded by October.83 The delegation’s first task was thus to convince the Americans that the exchange would not be a bet on a losing horse. As Woodward-Nutt put it, “the value of a mission seems to be about 60 percent propaganda, 20 percent

82 Notes on meeting held at Thames House, Millbank, August 10, 1940. UKNA, AVIA 12/246; and Draft telegram to His Majesty’s Ambassador, Washington, April 23, 1940, UKNA, PREM 3/475/1.
83 Clark, Tizard, 269.
impressing upon the Americans the difference between operating equipment in war and peace conditions, and 20 percent in exchange of mutually useful technical information. Propaganda in all directions is badly needed.\textsuperscript{84}

At first the visitors found a certain “stickiness” and hesitation from their hosts, but a concerted effort by the British to forge personal contacts and relationships—as well as the incredible information they were willing to hand over—quickly warmed the attitudes of American officials.\textsuperscript{85} This outreach began, as we have seen, with Tizard himself, who took advantage of Lord Lothian’s extensive network of contacts to meet the most influential people in Washington, from the secretaries of the Army and Navy to President Roosevelt. He also used existing British ambassadorial, trade, and military missions in Washington, most notably the Admiralty Technical Mission (BATM) as a ready-made web of connections. The considerable value to the Americans of the knowledge the British were carrying, and their earnestness in releasing it without qualification, quickly became obvious, and only two weeks after Tizard’s arrival the War Department lifted most of its restrictions to exchange.\textsuperscript{86}

From September to November 1940 members of the mission crisscrossed the United States and Canada discussing their work, exchanging research, and exhorting their hosts to make as much beneficial use as possible of the information they were receiving. Setting up headquarters in a small block of suites in Washington’s Shoreham Hotel, they focused initially on the U.S. military, meeting with admirals and colonels responsible for weaponry. They repeatedly visited Army proving grounds,

\textsuperscript{84} Letter, A. E. Woodward Nutt to Dr. D. R. Pye, Ministry of Aircraft Production, September 19, 1940. UKNA AVIA 12/126.
\textsuperscript{85} Ibid.
\textsuperscript{86} Zimmerman, \textit{Top Secret Exchange}, 98-106.
the Naval Research Laboratory, and even observed a U.S. fleet battle practice in Honolulu. Soon they branched out to civilian organizations, including the National Defense Research Committee (NDRC) and Civil Aeronautics Administration (CAA). Since in many cases more advanced developments and technical discussions were the province of private industry, the mission was referred to firms like Lockheed, Sperry, RCA, Bell Labs, GE Labs, and Boeing. Meetings on uranium fission were held with eminent academics like Enrico Fermi, the recent émigré to Columbia University. The British urged their hosts to discuss any and every state-of-the-art technology, from aircraft turrets, rockets, and radar, to submarine detection, explosives, chemical weapons, and medical research. The delegates encouraged questions and requests for information, and even brought film reels to show the Americans their innovations in action. They also gave secret details gleaned from picking apart German planes shot down over Britain, spurring American air commodores to request that specimens of the actual Nazi aircraft be sent over. Finally, Americans themselves were invited to the UK to take away secrets directly. By personal, handwritten arrangement between Churchill and the White House, President Roosevelt’s trusted personal aide (and later OSS director) William Donovan was smuggled into 10 Downing Street, given access to GCHQ and Bletchley Park, and provided with details on the state of Britain’s radar and atomic weaponry research.

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88 Henry Tizard, “Notes on Meeting Re Aircraft Armaments, Etc.,” September 18, 1940. UKNA, AVIA 10/1.
The exchange thus yielded enormous enhancements for the United States on a range of state-of-the-art, prestigious technologies, from aircraft turrets and rockets to submarine detection, explosives, chemical weapons, and medical research. The value of this was almost immediately obvious to the Americans: Not only did U.S. officials lift existing prewar restrictions to technical exchange within weeks of Tizard’s arrival, but they also began clamoring for British secrets so enthusiastically that their requests overtaxed the small delegation, forcing Tizard to call in Canadian scientists as British stand-ins for many mission meetings. The recently installed head of the civilian sector of American state research, Vannevar Bush, wrote eagerly to Secretary of State Cordell

90 Zimmerman, *Top Secret Exchange*, 112. The involvement of Canada in the transatlantic research partnership is beyond the scope of this chapter, but David Zimmerman covers it comprehensively in *Top Secret Exchange*, chapter 8. In brief, the Mission intended to take advantage of R&D and manufacturing in Canada from the beginning, given that nation’s Dominion status, its extensive resources and infrastructure, its close ties with the United States, and its position outside the threat of Nazi invasion. Canada exhibited a keen willingness to help Britain’s scientific war effort, as well as boasting excellent laboratories and facilities, but it also displayed inadequate military research and needed a significant boost from the Mission to get advanced R&D underway. (Zimmerman, 155-166). The Americans included close exchange with Canada in the plan from the beginning, with Vannevar Bush establishing channels through the NDRC for liaison with Ottawa, and using Professor R.H. Fowler as a particular node of exchange (Letter, Vannevar Bush to Frank Knox, October 30, 1940, OSRD, Records of the Liaison Office, RG227, Entry 168, Box 9, NARA). Canada was also often invoked as a potential bureaucratic and legal workaround when issues like patents and secrecy arose. For example, amid American neutrality regulations, in June 1940 the British Air Attache proposed sending Canadians to Wright Field to observe the use of a new type of American bomb, whence they could proceed to Britain with the information (Telegram, Air Attache, Washington to Air Ministry, June 14, 1940, UKNA, PREM 3/475/1). And when Tizard realized his mission was not empowered to negotiate patent issues for the manufacture of British goods for the U.S. Services, his first reaction was to try to get the items manufactured by the Canadian company Research Enterprises, who could then sell it to the Americans (Letter, Henry Tizard to Director General, British Purchasing Commission, September 30, 1940, UKNA, AVIA 10/2). Thus, ‘via Canada’ became an important channel for information and potential diplomatic solutions, and Canada itself (as Zimmerman argues) played an important role in advanced research as the war went on. Also note that in 1941 other Dominion governments, notably Australia and South Africa, joined the “liaison club” (Letter, Australian Legation, Washington, to Honorable Cordell Hull, May 15, 1941; OSRD, Records of the Liaison Office, RG227, Entry 168, Box 10, NARA; and Letter, W.L. Webster to Carroll L. Wilson, July 28, 1941, ibid., Box 8).

Hull that the United States had been “greatly assisted” by the “very substantial value” of the mission, which now allowed the U.S. to establish its own derivative research projects on “problems which are of the greatest importance from a military standpoint.” Tizard, too, was pleased with the Americans’ enthusiasm to make full use of Britain’s secret technologies, and confidently forecast to London in October that they should now expect “a rapid advance in the U.S.A., particularly as a result of the information we have given them.”

A trade imbalance

Nevertheless, this “rapid advance” was only necessary in the first place because of America’s longstanding position of inferiority in state-science. When the British arrived in Washington they found their suspicions about the east-to-west balance of exchange largely confirmed, but in some ways the American science situation was worse than they’d thought. Tizard reported back to Churchill that, as expected, “broadly speaking, the Americans are far behind us,” which he deemed a natural outgrowth of their lack of war incentive. Only a few scattered inventions seemed of immediate use to the British—a gunnery director, a blind aircraft landing system, and the Norden bombsight that the U.S. still refused to release. But many other technologies the Americans considered cutting-edge were deemed unsuitable or inferior by the British delegation.

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92 Bush, Vannevar to Honorable Cordell Hull, November 20, 1940, letter, OSRD, Records of the Liaison Office, Entry 168, Box 10, RG227, NARA.
93 Report, H. T. Tizard to Prime Minister, October 19, 1940. PREM 3/475/1, UKNA.
94 Ibid.
Tizard began to worry that this U.S. unpreparedness would mean that Britain “shall not get enough of what we want, nor shall we get it in time.” And he was not alone in thinking so. In one important episode from the following summer, Australian scientist Marcus Oliphant, officially unattached to Tizard’s mission but a key figure in British radar development, was horrified to realize that the United States had taken little practical action on atomic weaponry. The Tizard Mission had passed American officials the bombshell Frisch–Peierls Memorandum—the first true elaboration of the implications of nuclear weaponry—but Lyman Briggs, the head of the Advisory Committee on Uranium, had simply filed it in his safe. Oliphant was beside himself. Taking matters into his own hands, he secured passage on an unheated bomber across the Atlantic for a series of urgent personal meetings, including with a seemingly uninterested Vannevar Bush, who granted Oliphant just twenty minutes. Undeterred, Oliphant continued his journey, forcefully exhorting the crème of the American academic science scene—most notably Fermi, Lawrence, and Harvard president James Conant—to make atomic bombs a more urgent priority. The weight of their collective opinion finally convinced Bush to press Roosevelt on accelerating the embryonic American program, and in October he pitched a set of what historian Richard Rhodes calls “British calculations and British conclusions” to the president. This had the desired effect. Tellingly, Roosevelt immediately turned to “the question of how the United States was attached or might attach itself to the British program.”

95 Ibid.
As this episode illustrates, British delegates quickly recognized that the primary shortcoming for the United States was not a lack of talent, but rather institutional underdevelopment. There was certainly no shortage of top-flight researchers at elite U.S. universities, and American manufacturers had proven themselves adept at absorbing and improving even the most advanced new scientific principles. But the fact remained that there was little cooperation between different segments of American R&D, and little high-level commitment to state technological command.

The mission also found itself unwittingly caught up in the Americans’ inter-organizational jealousies. The visitors were baffled to discover, for example, that civilian, defense, industrial, and academic research all seemed to exist in separate fiefdoms, and worse, that this was mostly intentional, borne of outright hostility between sectors. Top Navy brass still resented the idea of working with civilians, just as they had before the war, and tried to limit Britain’s access to the NDRC, a new nonmilitary agency led by Bush. And relations between the services themselves were no better—when the Army shared radio research with the NDRC, for example, the committee was obliged to keep it a secret from the Navy, and vice versa.

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98 Report, R. H. Fowler visit to Naval Research Laboratory, Anacostia, August 30, 1940, AVIA 10/1, UKNA.
This slipshod state-science mobilization was reflected most damningly in the military draft that came into effect during the mission’s stay in Washington. The conscription rules made no provision for the retention of scientists, researchers, or students in training, with the result that many competent ‘technical men’ were sent to the front as ordinary foot soldiers. When scientists protested, draft officials argued that young men of student age were too untrained and inexperienced to be irreplaceable to American science. As academics contended, this took a noted psychological toll on the lab work of young potential call-ups. It also forced industrial firms to pour enormous energies into lobbying Selective Service officials for the retention of essential researchers. Science administrators would later bemoan the way the U.S. lived off European scientific capital while it “squandered” its own technical manpower. Front-line countries in much more immediate need of infantry—Britain and Russia among them—nevertheless refused to “liquidate their scientific resources to furnish cannon fodder.” The draft only seemed to further prove the American government’s relative lack of commitment to science.

Given these shortcomings, the British delegates felt that it fell to them to incubate and guide the American science apparatus. If it was to become useful at this late stage against Hitler, there was simply no alternative. Thankfully, they found the Americans to be increasingly willing partners. As Tizard reported to London, “things are moving apace in Europe and there is little doubt that the U.S.

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100 Statement, Norman Arthur Shepard, Manufacturing Chemists’ Association of the United States to House Armed Services Committee, April 16, 1948, box 103, Vannevar Bush papers, LoC.
101 A limited fix for this glaring omission wasn’t passed until 1944. Ibid.
is beginning to feel the draught.” But that didn’t change that “the U.S. Army and Air Force is equal to that of Bulgaria and possibly a little inferior.” There was huge potential in the U.S. industrial machine, the British knew, but the Americans failed to grasp the scope of necessary commitment, nor the requirements of real operations in real war. For that reason, it was essential—and perhaps central to the survival of the United Kingdom—that top British scientists and administrators make sure that, as the great American state-science machine cranked to life, it be imbued with British experience and shepherded to British specifications.

Given how recently bilateral relations had been icy and mistrustful, British officials realized that their guidance would need to be subtle and discreet. The exchange would be most successful if the Americans felt gently encouraged, even made to feel they were leading proceedings, rather than being dictated to by their British counterparts. Upon return to London, Tizard laid out the need for careful diplomacy:

[The U.S.] has neither the operational experience, nor, in many directions, the technical knowledge that we have; and unless we can get both quickly across to them, in the friendliest collaboration, the bulk of American industrial effort will be diverted to the production of war equipment of inferior quality. . . What we must do, I suggest, is to act quietly and not ostentatiously as advisers to the U.S. forces; to convince them that what we want is best for their purposes as well as for ours; and to be ready to compromise quickly when by

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103 Letter, Sir Henry Tizard to (recipient not listed), July 9, 1940. UKNA, AVIA 12/246.
104 “Notes of a meeting in connection with Sir Henry Tizard’s mission to America (1940), held at the Ministry of Aircraft Production,” October 14, 1940. UKNA, AVIA 12/246.
compromise we can get production and delivery of what is good instead of a failure to produce something better.105

More than any other area, this advisory role was most urgently needed with regard to incorporating American civilian scientists into the overall war effort. As we have seen, civilians had spent many decades—sometimes by ideological choice, sometimes by prevailing circumstance—walled off from an American state in the thrall of military men who often refused to talk to each other, let alone outsiders. Only now, with war looming, were more academics being tentatively looped into the government’s activities. Politics and ideologies behind the status quo, however, were difficult to change. When Vannevar Bush wrote to the Secretaries of War, Navy, and State imploring them to allow his fledgling civilian NDRC to work directly with scientists in Britain, his words clearly reflected both the priorities and the machinations of the British delegates. As he wrote to Cordell Hull, “a more direct contact” was not only crucial to the war effort, but was also being urged by the British themselves, who insisted that “only through such direct contact can the maximum benefit be obtained from this plan of exchange.”106

The presence of the British, then, helped to ease the transition toward a functional relationship between civilian scientists, government administrators, and the military. As one American civilian science chief noted at the end of the war, “perhaps the most far-reaching benefit” of exchange with Britain was the “constant encouragement that they gave us … encouragement all

105 Report, H. T. Tizard to Prime Minister, October 19, 1940. UKNA, PREM/3/475/1.
106 Bush, Vannevar to Honorable Cordell Hull, November 20, 1940, letter, RG227, NARA.
the more welcome because it was conspicuous by its rarity among our own associated Governmental agencies.”

The British, however, didn’t just encourage cooperation between squabbling parties. The mission also directly intervened in codifying that cooperation through reconstruction and reorganization of the U.S. research bureaucracy. They attempted, that is, to calibrate American statebuilding to British specifications and along a British model.

**Britain, Radlab, and the ascendance of U.S. civilian state-science**

The assimilation and encouragement of civilian scientists would soon pay off in a significant way, as the persistent efforts of the British to leverage American civilian resources created an institutional domino effect that would leave a profound legacy on the contours of U.S. state-science in the coming decades. The sheer volume and advanced nature of new information the British gave—and the urgency with which they exhorted the Americans to make use of it—inundated private firms’ labs, overtaxed the feeble government mechanisms available to oversee it, and called into being an unprecedented nexus of academia, industry, and the state attacking a broad front of technological problems together, in order to extract maximal gain from the exchange.

Such a heterogeneous mixture—more resembling European states’ science organizations than anything Americans had been accustomed to—confronted the U.S. government with an obvious need for more effective bureaucratic coordinating mechanisms. But American officials only fully embraced this necessity when historical happenstance forced their hand—that is, after they witnessed the

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107 Letter, L.H. Adams to Dr. W.E. Story Jr., OSRD, November 1, 1945. RG227, Ent. 169 (NC-138), Box 46, NARA.
breathtaking success of a new program that they and their British visitors constructed for the development of radar.

Radar was Britain’s single most urgent technological priority in 1940. Radio detection of ships and especially aircraft had represented an urgent matter for British authorities since it was first identified as a feasible reality, half a decade earlier, in a secret memorandum by National Physical Laboratory scientist Robert Watson-Watt. Watson-Watt’s proposal was so explosive—and its military implications so profound—that an R&D program headed by Sir Henry Tizard began within five weeks, and a radio laboratory at Orford Ness opened within two months. The lab tracked its first aircraft, at a distance of 46 kilometers, just twenty-nine days later.108 The ultimate fruits of these tests—the first stations in an integrated radar defense system for southeast England, known as Chain Home—went online in August 1938.109

Radar continued to enjoy top priority for both the Air Ministry and Admiralty (the latter championed by then-MP Winston Churchill), and development continued apace.110 The result was that by the time Bowen set off to join Tizard in America, the most prized item in his solicitor’s deed box was a working example of the world’s most advanced radar component, the resonant cavity magnetron. The British techno-state’s most prized secret in 1940, the magnetron was a revolutionary microwave generator perfected that same year by scientists at the University of Birmingham. It was a

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thousand times more powerful than the ineffectual 10-watt klystron developed at Stanford and, critically, it was hand-sized. In allowing powerful frequencies to be transmitted from a portable device, it represented the skeleton key to unlocking an operational long-range radar system.\textsuperscript{111} And now, as the Battle of Britain raged, the delegation needed American institutions to help develop the apparatus as quickly as possible for mass production.

But the radar situation in the U.S. looked very different than that of Britain. Prior to 1940, American research into radar had been mostly for-profit and uncoordinated. Advancements at Stanford University in short-wavelength radio signals—dubbed ‘microwaves’—catalyzed an upsurge in academic and industrial research, and by the late 1930s the likes of RCA, GE, Sperry, Bell Labs, MIT, and the Carnegie Institution were all working on rudimentary ‘airplane detection’ problems. True to prewar U.S. form, however, industrial secrecy and commercial rights remained paramount, despite an overall lack of practical progress. GE claimed to have “accomplished great things” in radar, but would tell no one any details, including the Army.\textsuperscript{112} Sperry, on the other hand, pursued the Army vigorously, since the company owned key rights to microwave knowledge and potentially stood to make a profit from its military use.\textsuperscript{113} The armed services undertook programs of their own, beginning at the Naval Research Laboratory in 1930, but in 1937 the NRL took the decision to abandon microwave research altogether in favor of long-wave. Ultimately, the Americans proved

\textsuperscript{111} Clark, \textit{Tizard}, 268.
\textsuperscript{112} Letter, Vannevar Bush to Gordon Rentschler, January 5, 1940. Box 95, Vannevar Bush papers, LoC.
\textsuperscript{113} Letter, Vannevar Bush to Karl T. Compton, May 4, 1940. Box 26, Vannevar Bush papers, LoC.
unsuccessful in developing a means of generating microwaves powerful enough to achieve practical radar operations. This failure was to prove fateful in ways no one could have foreseen in 1937.

The War and Navy Departments had taken great pains to keep the transatlantic exchange purely a military matter, but their prior abandonment of—and thus lack of competence in—microwave research had the unintended effect of pushing the Tizard Mission’s radar personnel into the arms of American civilian scientists. As historian David Zimmerman has argued, the British unwittingly stepped into the middle of an acrimonious struggle over control of American science between military brass—who resented intrusion from academic ‘longhairs’—and civilian science administrators who bemoaned the lack of technological awareness of the armed forces. Military

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114 Zimmerman, *Top Secret Exchange*, 134. The Signal Corps also conducted radar research, but interdepartmental jealousies meant that both it and the NRL kept the programs secret from each other and were unaware of their parallel investigations. The NRL’s radar program was spearheaded by Robert Page and Leo Young. In 1933 exploration began into the observed phenomenon of radio echoes bouncing off ships. Continuous-wave transmissions proved ineffective and Page’s team began experimenting with a pulse transmitter to detect the echoes. Working prototypes were constructed in 1935 and 1937, and shipboard experiments of a “bedspring” radar installation were conducted by Rear Admiral Maurice Curts on the U.S.S. *New York* in 1939. Ultimately, a hard ceiling existed on the possibility of success in all such U.S. radar programs, because American technology at the time limited them operationally to precentimetric (longwave) frequencies (the minimum length then achievable was 200 mHz). These longer frequencies meant impractically large transmitters and an ineffective, limited detection range. The other issue was lack of high-level interest. Although Congress appropriated some funding for the NRL project in 1935, the program was, as one military historian put it in 1951, beset by “much backing and filling,” infighting, etc. Moreover, when the OSRD finally took up microwave research, Admiral Bowen of the NRL fiercely opposed it, insisting that longwave was the only valid program to undertake. (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* 16:1, January 1975, p. 23). The prewar British program under Robert Watson-Watt, on the other hand, quickly received official support and resources. This enabled Britain to successfully implement the Chain Home (CH) system, despite the fact that it, too, relied on longwave before the perfection of the cavity magnetron (microwave generator) in 1940. Letter, Henry Guerlac to Dr. Vannevar Bush, May 21, 1951; Letter L.A. DuBridge to Vannevar Bush, May 21, 1951; Letter, F.I. Entwistle to Vannevar Bush, May 22, 1951. Box 95, Vannevar Bush papers, LoC. See also Bowen, *Radar Days*, chapters 1-9, for a technical narrative on the British developments under Watson-Watt.

leaders had generally held the political upper hand in these debates, given their success in World War I and their influence on Capitol Hill.

Nevertheless, a small but growing faction of civilians believed the military to be imperiling America’s footing for the imminent war by dragging its feet on research and development. And now the Tizard Mission—aware of but not immersed in these internal political struggles—threw a wrench into the military-civilian dynamic, as responsibility for developing Britain’s groundbreaking magnetron suddenly and unavoidably fell to the only U.S. government agency working on microwaves, the NDRC. In doing so, it fell into the jurisdiction of the NDRC’s leader, who also happened to be the foremost exponent of the view that the military needed to bring civilian scientists into leadership roles: the engineer, scholar, and Carnegie Institution president, Vannevar Bush.

Born in Massachusetts in 1890, Bush had spent the decades before World War II building an enviable reputation in various wings of the American science establishment. After receiving a joint doctorate in electrical engineering from Harvard and MIT, he co-founded the Raytheon Corporation and made a small fortune from its patents. In 1932 Bush was appointed dean of the MIT School of Engineering, and in 1938 he rose to leadership of the powerful Carnegie Institution, described as the “biggest scientific empire under one roof in the world.”116 He also came to increasing public

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116 S.J. Woolf, "Chief of Staff on the Science Front: Dr. Bush Directs a Research Staff that Spends Almost $3,000,000 a Week to Develop War Weapons," *New York Times*, January 23, 1944.
prominence through a series of successful inventions, the most notable of which was the differential analyzer, an early analog computer aimed at solving differential equations.\footnote{Bush has loomed large in the historiography of American science, beginning essentially from the end of the war. This began with Bush himself, who played a hand in compiling the first official chronicle of the OSRD, Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development (by Irvin Stewart [Boston: Little, Brown & Co., 1948]); and who featured centrally in the more blatantly celebratory Scientists Against Time (by James Phinney Baxter [Boston: Little, Brown & Co, 1946]). He also published his own story through major memoirs like Pieces of the Action (New York: Morrow, 1970). Subsequent treatments of Bush’s biography have ranged from the hagiographic to the critically revisionist, mostly centering on whether his ‘vision’ (as laid out in his 1945 report Science: The Endless Frontier) was or was not central to the postwar relationship between American government and science, and whether his advocacy for the NSF was a self-serving political maneuver or a genuine defense of science’s ability to self-regulate without government oversight, etc. Indeed, ‘Vannevar Bush’ has almost itself become a shorthand to refer to a state program of civilian academic research in aid of the tripartite goals of national security, industrial strength, and improving the quality of life, as in “Updating Vannevar Bush: Academy Panel Calls for a New Strategy for Science,” (Irwin Goodwin, Physics Today, July 1993). For more on Bush, the NSF, and the debate over the shape of U.S. science in the first decade after the war, see this dissertation’s Chapter 3. For more about the politics and historiographical distortion of Bush as architect of postwar American science, see Daniel S. Greenberg, Science, Money, and Politics: Political Triumph and Ethical Erosion (Chicago: University of Chicago Press, 2001), p. 51-58. See also: G. Pascal Zachary, Endless Frontier: Vannevar Bush, Engineer of the American Century (New York: Free Press, 1997). For the purposes of this chapter, this decades-long debate is itself, essentially, the point—no matter his political views or direct influence on the direction of postwar science administration, Bush did become a lionized figure, and the OSRD became an oft-cited example in postwar political debates of successful civilian state-science in action. The symbolic importance of Bush (as sober science administrator) as a public ‘character,’ and of the OSRD as begetter of scientific victory in the war, were crucial to what came next, and the British exchange, in turn, was crucial to their legitimation and growth.}

Bush’s worldview on science organization had been shaped by personal frustrations he encountered in his dealings with the government, of which he had intimate knowledge thanks to his service in the NRC and NACA. In particular, he distrusted military officials’ narrow-mindedness on questions of science and technology. During the First World War, he had attempted to pitch a magnetic submarine detection device to the Navy, but was brushed aside and forced to appeal to J.P. Morgan for funding. As war approached again, he decried what he saw as ongoing foot-dragging by military brass on key areas of research. The “caste-conscious” War and Navy Departments, he
thought, always insisted on fighting every war with the weapons of the previous one, and resented innovations that might disrupt their ingrained habits and assumptions.\[^{118}\] He believed that an infusion of civilians, with their new ideas and different ways of working, was an indispensable step if the U.S. intended to keep up with the powerful techno-states now pursuing world war.

This philosophy led Bush in 1940 to lobby the Roosevelt Administration to create a new organization that would coordinate civilian scientists for the impending war effort and force more open relations between military and nonmilitary research. Bush’s Carnegie appointment made him a well-known figure in Washington, and he was easily able to secure Roosevelt’s approval for a new body, dubbed the National Defense Research Committee. As created, however, the NDRC was small, relatively powerless, and funded only through small sums diverted from the president’s emergency fund. Indeed, the resources of the NDRC were so dubious that, as late as May 1941, MIT president Karl Compton was forced to write to John D. Rockefeller Jr. to beg for private philanthropic underwriting for the university’s sizeable NDRC commitments—a situation, he acknowledged, that was “decidedly embarrassing all-around.”\[^{119}\]

Compounding the lack of resources was the fact that, predictably, military leaders opposed the NDRC’s existence. As we have seen, the Navy attempted to restrict the Tizard Mission’s access to the NDRC, and branch chiefs petitioned furiously to the White House against granting it any authority. As pressure mounted, Roosevelt was forced to acquiesce to the generals and admirals, and mandated that the NDRC not undertake research in scientific fields already being covered by military


\[^{119}\] Letter, Karl T. Compton to John D. Rockefeller, Jr., May 8, 1941. Box 26, Vannevar Bush papers, LoC.
branches—it was left, that is, to pick up the crumbs of projects unwanted by Army and Navy scientists. Serendipitously, however, one of those crumbs happened to be the microwave program abandoned as unfeasible by the Naval Research Laboratory three years earlier.

Thus, in trying quickly to hand over their groundbreaking cavity magnetron, the British unwittingly chose the winner in a pitched political battle. Because the NDRC had inadvertently become the primary American outlet for microwave projects, the British mission zeroed in on Bush and his team to be the key conduits for developing the technology. This, in turn, catapulted the NDRC to the highest echelon of war science work. Since radar production was Britain’s top priority for the exchange, in negotiating with Whitehall about allowing mission members to extend their visit, Tizard didn’t hesitate in suggesting bluntly that key experts were winning the war by working on radar in the U.S. instead of returning home. The magnetron astonished the Americans, and the urgency of the British need to rapidly perfect and mass-manufacture it meant that the U.S. military had no choice—Navy secretary Frank Knox and Army secretary Henry Stimson had to grant permission for Tizard’s men to deal directly with Bush and the NDRC. The floodgates were now open for American civilian scientists. Almost immediately, Taffy Bowen began clambering aboard

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120 Zimmerman, Top Secret Exchange, 134.
121 Talk of this kind particularly centered on Professor Cockcroft, Ministry of Supply, who was considered so valuable that he was urgently recalled back to the UK in October 1940. This met with fierce resistance from Tizard and other mission insiders. Report, H. T. Tizard to Prime Minister, October 19, 1940. UKNA, PREM/3/475/1.
122 Letter, Vannevar Bush to Honorable Frank Knox, October 30, 1940; and Letter, Frank Knox and Henry Stimson to Vannevar Bush, October 24, 1940. OSRD, Records of the Liaison Office, RG227, Entry 168, Box 9, NARA.
American aircraft, installing airborne radar and transponder units and instructing his American counterparts in their development.\textsuperscript{123}

Bush’s committee, of course, still had limited means and negligible bureaucratic power. So, true to prewar American form, the NDRC was compelled to turn to the capital, influence, and intellect of a wealthy private philanthropist with a keen scientific bent: the financier and inventor Alfred Lee Loomis.

A graduate of Harvard Law School and cousin of Henry Stimson, Loomis spent World War I as a lieutenant colonel in the Army, working on ballistics research at Aberdeen Proving Ground. After the war he moved to the world of Wall Street, where he made a sizeable fortune in investment banking. His lifelong interest, however, was in research and laboratory work. A true scientific polymath, in the 1930s Loomis bankrolled a substantial private research lab at his estate in Tuxedo Park, New York, which boasted some of the finest instrumentation in the world, superior to that of even the top research universities. As eminent physicist Luis W. Alvarez later remembered, one of the most prestigious invitations a physicist could receive in the interwar years was to spend a summer at Tuxedo Park with Loomis’s assembly of guests, including the likes of Albert Einstein, Niels Bohr, and Werner Heisenberg. Loomis also gave money—usually anonymously—to any project that appealed to his belief in science, from spectroscopy to atomic physics to electroencephalography.\textsuperscript{124}

\textsuperscript{123} Zimmerman, \textit{Top Secret Exchange}, 128.
\textsuperscript{124} Luis W. Alvarez, “Alfred Loomis,” \textit{Physics Today}, 28 (11):84, 1975, and Conant, see below. Loomis is sorely overdue for serious academic study. The only monograph available on his life is the thorough, but non-academic:
In the late 1930s, Loomis joined the fray of independent American groups studying the radar question, and, working with MIT, constructed a crude microwave prototype in the back of a van at a nearby golf course. Recognizing this work, as well as Loomis’s scientific abilities and considerable capacity for organization and liaison, Bush appointed him to the NDRC upon the outbreak of war in Europe, placing him in charge of its D-1 detection division. Thus, when the Tizard Mission arrived, Loomis was already ready as an obvious interlocutor for radar exchange. He quickly invited the British visitors to Tuxedo Park, where the delegation gave a demonstration of the magnetron for a collection of academics and industrialists. As Bowen remembered, “The atmosphere was electric—they found it hard to believe that such a small device could produce so much power and that what lay on the table in front of us might prove to be the salvation of the Allied cause.”

The British visitors were pleased that their top technological priority had, in the NDRC and Loomis, so easily found an administrative home and competent leader in the United States. By American standards, Loomis was a foremost expert on radar, and the British were impressed with the enormous speed with which he absorbed and began to develop their data, as well as the nimble way in

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Jennet Conant, *Tuxedo Park: A Wall Street Tycoon and the Secret Palace of Science That Changed the Course of World War II* (New York: Simon & Schuster, 2002). Loomis actively militated against receiving credit for his work, resources, and contributions to important scientific developments, which perhaps explains some of his historiographical anonymity. As this chapter tries to show, Loomis was a crucial figure in developing Radlab and American radar to British specifications. He was also an important liaison and trusted ambassador between military and civilian realms, particularly given his influence with his cousin, Stimson. As Alvarez, himself one of the most important scientists of the century, wrote, “There is little doubt that the solid support given by the Army to the Manhattan District was enormously helped by a long series of secret briefings given to Henry Stimson by Alfred Loomis, concerning the activities of his friends Ernest Lawrence, Enrico Fermi, Arthur Compton, and Robert Oppenheimer,” (Alvarez, “Alfred Loomis”).

which he pulled scientists, firms, and committees together. But the organizational capacity of the NDRC was still inadequate for the kind of major development they envisioned. It became clear that, if radar was going to be developed for mass-manufacture in time to turn the German tide, the British mission would need to guide their American partners in constructing a new type of bureaucratic apparatus for efficient and large-scale applied science work.

The Americans, for their part, recognized the need to take advantage not only of British technical knowledge, but also of the visitors’ organizational experience. Britain, after all, had had years’ worth of head start in devising a joint government-academic research laboratory for radar. Bush, Loomis, and others therefore asked the visitors directly for help. Loomis convened a meeting with Tizard delegates, scholars Edward Bowles and Ernest Lawrence, and NDRC officer Carroll Wilson at Tuxedo Park on October 12th, and indicated that the organization’s first priorities should be whatever the British needed them to be. After a brief consultation, Loomis proposed the establishment of a large, centralized microwave laboratory based on the British model. As in Britain, it would be staffed by scientists and engineers from academia and industry, and while it would be civilian-run, it would work in close consultation with the needs of the military. Tizard’s policy of projecting careful diplomatic guidance in the exchange, rather than ostentatious dictation, seemed to be paying off.

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126 Report on a visit to Dr. A. L. Loomis’ Laboratory at Tuxedo Park, November 3, 1940. UKNA, AVIA 10/2.
Once both sides began to hammer out the needs and logistics of the new radar laboratory, events moved rapidly. Based on his preexisting relationship with MIT, Loomis selected the university’s Cambridge, Massachusetts campus as the location for what he dubbed the Radiation Laboratory, or Radlab. Within two weeks, the university had cleared 18,000 square feet of floor space for Loomis’s team. Within a month, a staff of more than thirty top physicists and communications engineers had been assembled, with Ernest Lawrence acting as “principal recruiting agent” by personally telephoning “every physicist of consequence in the United States.” Loomis, meanwhile, contracted for the production of magnetrons and other equipment—all to British specifications—from commercial firms Bell Labs, RCA, GE, Western Electric, Raytheon, and Sperry, to begin delivery within thirty days—an astonishingly rapid concept-to-production speed for U.S. industrial contracting at the time.

From the very beginning, Radlab was a fundamental product of the British mission’s close guidance and scrutiny. The Tizard Mission’s radar experts—Bowen, Cockcroft, and Ralph Fowler—took the lead in molding the lab’s selection of projects and priorities, and held repeated, lengthy conferences with Loomis, the NDRC, and the military to delineate the order and manner with which work should proceed. The result was a multi-pronged front of projects touching all known corners of radio and microwave work: IFF (air-to-air identification transponders); blind landing systems;

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131 Report on a visit to Dr. A. L. Loomis’ Laboratory at Tuxedo Park, November 3, 1940. UKNA, AVIA 10/2.
ground-based radar chains; and enemy signal interception. After further consultation with the British, yet another device was moved to top military priority status—a long-range hyperbolic navigation system known as LORAN, developed initially by Loomis’s team but later improved and streamlined by a visit from Robert Dippy, creator of Britain’s already-extant GEE navigation network. By the start of the new year, a flow of secret radio equipment developed by the British was flowing west across the Atlantic for use by Radlab, and early working production devices from U.S. firms were flowing east for deployment in the UK.

But technological guidance wasn’t Britain’s only contribution to Radlab. The mission members also brought with them an organizational tradition and working knowledge lacking in the U.S. at the time. After the war, Radlab director Lee DuBridge recalled that “the whole direction, and even much of the detail” of the laboratory’s development was stimulated and guided by the British, and by Taffy Bowen in particular. While the cavity magnetron was the key catalyst, beyond it the “full set of operational and technical specifications” provided by the British profoundly determined the contours of institutional development. Specifically, Radlab was closely modeled on Britain’s

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132 Letter, Alfred L. Loomis to Vannevar Bush, November 27, 1940. UKNA, AVIA 10/2; and Report on a visit to Dr. A. L. Loomis’ Laboratory at Tuxedo Park, November 3, 1940. UKNA, AVIA 10/2.

133 The LORAN system developed at Radlab with the help of the British GEE team later became a successful aerial and maritime navigation system for both military and civilian users, and was further modified and improved by firms contracted to the U.S. military throughout the Cold War. LORAN continued to be used—albeit as marginal technology following the rise of inertial and GPS navigation—until 2010, when the last transmitters were shut down by the U.S. Coast Guard. For technical details on LORAN and its predecessors, see Pierce, McKenzie, and Woodward, eds., MIT Rad Lab Series Volume 4: Loran (New York: McGraw Hill, 1948), digitized by Jefferson Lab, https://www.jlab.org/ir/MITSeries/V4.PDF

Telecommunications Research Establishment, and “depended almost exclusively on TRE” to get its start.135

The Telecommunications Research Establishment had been established as Bawdsey Research Station in Suffolk in 1936 to perform work for Tizard’s Scientific Survey for Air Defence. Its leaders quickly fostered a cooperative working strategy that would prove vital to the American laboratory: Disregarding security concerns, Tizard invited scientists from the universities of Oxford, Manchester, Cambridge, Birmingham, and London—some eighty in all—to report to Bawdsey for a “long vacation.”136 The scheme was a success, both scientifically and organizationally. By the midpoint of the war the initial staff of 38 had grown to more than 3,000.137 The TRE played a key role in developing both the Chain Home detection and GEE navigation systems, flew the first airborne radar prototype, and during the war served as the locus of Britain’s clandestine battle with Germany over radar signal jamming.138 The laboratory’s importance was obvious, and it had direct support from the highest levels, including Air Ministry official Sir Robert Renwick and Winston Churchill himself.139

139 Lovell, Echoes of War, 87; and Rowe, One Story of Radar, 199.
On the most basic level of transatlantic influence, the TRE served as a direct conduit of Anglo-American science exchange. Collaborating with their new partners, the heads of TRE organized a British Branch Rad Lab (BBRL) and an American-British Laboratory (a radar countermeasures lab), both under the auspices of TRE at Great Malvern.140 The young Americans sent to work in these exchange laboratories were exhilarated by the opportunity to learn directly from “national heroes” like Watson-Watt, and took full advantage by probing their hosts for scientific details and theories, working out new ideas with them on scraps of paper. They also received comprehensive briefings from leaders like Taffy Bowen who, in the telling of the American visitor H. Guyford Stever, offered “a lot of hints as to who was doing what and why. So getting into the flow of information in the magnetron period was as easy as pie because of the exchange.”141

More importantly, in the TRE we see the prototype of an organizational nexus that was key to Radlab’s effectiveness, and even the germ of the model for the Manhattan Project. Crucially, the TRE had represented a conscious effort to put scientists and military officers in intimate contact. As director A. P. Rowe later remembered, “I had been on Defence Science for 17 years before 1939 and a pet theme of mine was to get the Service people and the scientists together.” The TRE thus centralized the disparate activities of academic science, industry, and the military, allowing open, face-to-face research and problem-solving that was backed—but not controlled—by the state, yet free of the

141 Ibid.
secrecy concerns of the ‘invisible college’ model of dispersed research. It was precisely this intimate, even informal, atmosphere that the British successfully helped to transfer to Radlab. For example, the laboratory’s first major project—the development of a 10-centimeter air interceptor—was purportedly devised by Loomis and Bowen while sharing adjacent shower stalls at Tuxedo Park.

The experience of Tizard, Bowen, and others in TRE thus translated directly to the creation of Radlab, since setting up a major radar laboratory bringing together disparate sectors of the national science establishment was not a new experience to any of them. Like TRE, Radlab brought civilian scientists into close contact with the military and its strategic and technological needs. Like TRE, Radlab provided a focused, compact research center that allowed scientists and engineers to work together directly (bridging a professional divide especially persistent in Britain). Like TRE, Radlab experienced explosive momentum and growth, with both organizations increasing their research staffs into the thousands as the war progressed. And like TRE, Radlab enjoyed top-level support, with President Roosevelt alert to the urgency of the work of both Radlab and the NDRC more generally, just as Churchill had been with Tizard’s committee. Moreover, the success of both laboratories catalyzed intensive research into other areas that would have a profound impact on their national technological bases. TRE circuit and electronics research, for example, played a crucial role in the

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143 Compton, Karl to Vannevar Bush, May 9, 1951, letter, box, 95, Vannevar Bush papers, LoC.

development of the “Manchester Baby” electronic computer, while many Radlab physicists—including Loomis—moved on to prominent positions in the Manhattan Project.¹⁴⁵

The significance of Radlab and the British hand in creating it is thus twofold. On a scientific level, the British served as enabler for creating the laboratory, and the laboratory over the course of the war grew to become one of the largest and most significant research centers in the Allied world. It was responsible for the development of crucial, war-changing technologies, from detection to navigation, electronics to precision bombing, and even tested an early form of the airborne early-warning systems that were to play an enormous role in the ICBM standoffs of coming decades. By war’s end, twenty percent of American physicists had worked at the laboratory in some capacity, and Radlab-derived systems were in use by military services worldwide to a value of nearly $1.5 billion.¹⁴⁶ Radlab also served as the prototype for a nationwide network of copycat facilities working on a variety of critical war technologies, including the Jet Propulsion Laboratory at Caltech, the Radio Research Laboratory at Harvard, and the Applied Physics Laboratory at Johns Hopkins. Soon, the model was applied to the burgeoning U.S. nuclear program, which became known as the Manhattan


Engineer District. The Manhattan Project’s primary organizer was MIT president Karl Compton, who had been one of the keys to helping the British fold their bureaucratic designs into Radlab.¹⁴⁷

Most importantly, Radlab’s success proved the efficacy of a model of science organization largely untried in the United States before 1940. For the first time, civilians and academics worked hand-in-hand with military scientists and industrialists on a large scale, brought together by government organizers for nationalist purposes. The wild success of this British-inflected model in prosecuting a technological war made it much more difficult for detractors later to flout state-science mechanisms for the sake of bureaucratic rivalries or ideological suspicions. Specifically, the microwave program catapulted both the organizational configuration represented by the NDRC and the person of the civilian science administrator represented by Vannevar Bush into policymaking legitimacy.

In fact, the explosive growth of scientific activities under British guidance quickly made apparent that the NDRC had actually *outgrown* its means. As we have seen, the committee as was initially weak and underfunded. But with the British exchange in full flood and Radlab in operation, the financial and manpower needs for state science were mushrooming. At MIT, for example, the accelerating activities of NDRC, Radlab, and the military had swollen the cost of the university’s war

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work in just one year to match the normal operating budget of the entire rest of the institution combined. 148

Meanwhile, the experience of collaborating jointly with the British mission, and the close and sympathetic cooperation required to make Radlab effective, was slowly beginning to thaw relations between War Department leaders and civilian scientists. Even Bush noted that military attitudes had swiftly evolved from seeing scientists as mere “people with long hair” to recognizing them as practical, tough problem solvers who could “take it with the best.” 149 This, combined with the growing bureaucratic and fiscal pressures noted above, contributed to a growing consensus in Washington that while the NDRC’s work was vital, its feeble structure was adequate neither for continuing the exchange with Britain, nor for maintaining effective high-level links with military leaders and Roosevelt’s busy cabinet.

The result was an executive order, signed by Roosevelt in June 1941, to create a powerful new central node of civilian state-science, the Office of Scientific Research and Development (OSRD). Roosevelt retained Bush as its leader, and reconstituted the NDRC as a subordinate committee under the new agency’s umbrella. Now funded directly by Congress, the OSRD contained nineteen divisions working on specific areas in the physical sciences, as well as six divisions for medicine,

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148 Letter, Karl T. Compton to Vannevar Bush, October 8, 1941. Box 26, Vannevar Bush papers, LoC.
several advisory panels, and an entire unit dedicated to liaison with Great Britain.\footnote{Memorandum, Rear Admiral J.A. Furer, USN, Ret., to Secretary of the Navy, “History of Office of Coordinator of Research and Development from 12 July 1941 to 19 May 1945,” July 28, 1945. Box 32, Alan T. Waterman papers, LoC.} Most importantly, the OSRD was independent, flexible, and valued in the White House. Bush had relatively free reign to bring issues directly to Roosevelt, an important privilege not only for influencing the decision-making of the president, but also for exerting control over the vast array of scientists and administrators nationwide who Bush needed to bring into some semblance of working harmony. In short, access to Roosevelt brought political cachet to Bush and administrative muscle to the OSRD.\footnote{Don K. Price, \textit{Government and Science} (New York: New York University Press, 1954), 45.}

This joint civilian-military-industry-academic complex was new in American history. U.S. acceptance that the war ahead was going to be a technological one, and that the only organization capable of meeting a challenge of such scale was the state, was an unprecedented doctrinal shift. When Bush organized a counter-mission to send Americans to the UK to siphon away British research directly, Roosevelt considered it so important that he pulled James Conant from the presidency of Harvard to lead it. “For the full defense of the country,” he told Conant, “the efforts of scientists in cooperation with the Armed Forces is an essential element.”\footnote{Franklin Roosevelt to James B. Conant, February 4, 1941, letter, RG227, OSRD, Records of the Liaison Office, entry 168, box 10, NARA.} Such a creed emerging from the White House would have been unthinkable a decade earlier.
Observers at the time, as well as historians since, noted the sea-change in American science that the OSRD represented.153 By war’s end, the agency had spent more than $450 million on R&D, and had firmly solidified the process begun by the Tizard Mission, NDRC, and Radlab: to blur distinctions and divisions between academic, military, and industrial scientists and create nationalistic innovation and production capacity on behalf of the government.154 Its civilian nature, autonomy, and flexible methodology for pairing basic research to production and application—to say nothing of the enormous financial resources it wielded—made the agency successful in producing hundreds of new innovations where previous attempts at wartime state science had failed.

As Alexander King—the British chemist who had personally received the Conant Mission in 1941 at the request of Tizard, and whose role in the Anglo-American exchange included coordination of DDT work—noted, the NDRC and OSRD represented something unprecedented for the U.S. A majority of their projects originated from lists prepared by the armed forces, but they nevertheless retained “the right of initiative to sponsor new, promising, and often highly speculative developments suggested by recent scientific discovery, and freedom of judgment concerning what to undertake and how to carry it out.” In King’s estimation, this led not only to the creation of the technologies of

153 Debates about the importance of OSRD often mirror those about Vannevar Bush, and occupy the same historiographical territory. For more on OSRD, see also Owens, “The Counterproductive Management of Science in World War II,”—Owens argues that the OSRD was inherently contradictory, trying to imbue American state-science with a Twenties-era conservatism while inadvertently promoting its unchecked expansion and militarization. See also Gregory Hooks, Forging the Military-Industrial Complex: World War II’s Battle of the Potomac (Champaign-Urbana, Ill.: University of Illinois Press, 1991); Atkinson and Blanpied, “Research Universities: Core of the U.S. Science and Technology System;” and Stuart Leslie, The Cold War and American Science: The Military-Indusrial-Academic Complex at MIT and Stanford (New York: Columbia University Press, 1993).
victory, but also inaugurated a new paradigm in which “for the first time science was a major innovator in defense rather than a servant of conventional technology and invention.”

Despite this scale and infamy, however, the OSRD was shaped by various built-in limitations, mostly deriving from the need to graft a new and foreign way of organizing science onto an obstinate American political paradigm. Due in part to time and resource constraints, the OSRD differed from the British science model in eschewing in-house governmental research, deferring work instead to academia and industry. This was also a product of Bush and his cadre’s pre-New Deal conservatism—the contract system at the core of OSRD, that is, proffered government money but not government control. By taking contractors “on their own terms,” the state accommodated the self-regulating paradigm of academic scientists and the self-interested nature of commercial firms. This successfully coaxed competing parties into the same tent, but also made for a chaotic and undisciplined system of association that relied largely on the strongarmed leadership of Bush, and which became harder to control as the war went on. As we will see in the next chapter, this was to have important consequences for the Anglo-American technological relationship.


156 In considering the philosophy behind the OSRD’s “associationalism,” Vannevar Bush noted that, “There is a vast difference between a grant and a contract. The former implies paternalism, and with it control. Contracts are made only between independent bodies or individuals. Contracts carry responsibility but not subservience.” Owens, “The Counterproductive Management of Science,” *BHR*, p. 525. For more on the question of support versus control, see Don K. Price, *The Scientific Estate* (Cambridge, Mass.: Belknap Press of Harvard University Press, 1965). A prominent science and politics writer, as well as an official in the DoD’s Research and Development Board and an advisor to President Kennedy, Price lauded the OSRD as a counter-intuitive example of decentralization of authority during wartime (p. 73).
Although the OSRD thus developed key distinctions from the British system as it went forward, it is nevertheless important to underscore the centrality of the Tizard Mission to the rise of the agency and, therefore, of the U.S.’s wartime state-science complex. The practical combat experience the British relayed provided a carrot for formerly-distrusting American military officials, who craved information about the realities of new weapons and technologies in actual theaters of war. This, combined with the Mission’s determination to work with all facets of American science and not just the military, forced a climate of cooperation between academics and defense interests, however tentative. Such cooperation was crucial to the success of Radlab, which was catalyzed by the British magnetron and organized along a British model by advisory staff from the Mission. And the success of Radlab permitted the struggling NDRC to flower into the powerful OSRD. Thus, in only a few months, the transatlantic exchange had smoothed relations between squabbling factions of American science, unanticipatedly placed astounding new technologies into American hands, and put the U.S. on the road to having improved governmental mechanisms to take advantage of them.

The Tizard Generation

As David Zimmerman has convincingly argued, the British mission helped to bring civilian scientists into cooperation with the military. But the Tizard Mission was more than merely an institutional or even diplomatic phenomenon. Rather, the exchange and its aftermath represented a profound moment of rupture for the United States: It was an unprecedented push toward the large-scale embrace of state technoscience itself. And it marked the beginning of technology’s ascent.

toward centrality in the measurement of global power, a gauge that would become axiomatic among Americans and their international rivals by the 1960s—thanks in large part to the symbolic and material example set by the United States itself.

But that ascent was ultimately propelled by people—a specific set of people circulating through the laboratories and halls of American government. The exchange, the new institutions, and the new technologies embedded in the U.S. war machine, all had an impact on the minds and careers of people who were essential to the subsequent transformation of the American techno-state. Basic biographical sketches of even a few of these individuals clearly illustrate the way that the transatlantic exchange echoed in science and technology institutions in the United States and abroad in the coming decades.

Carroll Wilson. An MIT administrator—and, as it happens, an inveterate fan of British literature and husband to an English wife. Wilson in 1940 was selected by Bush to lead the NDRC’s liaison division, in which capacity he personally drafted the agreements that set the terms of the transatlantic exchange. The following February he helped lead the Conant mission to Britain, where he was instrumental in setting up the NDRC London office. After the war, he became advisor to the State Department on atomic issues, and eventually became the general manager of the Atomic Energy Commission (AEC). In the 1968 he joined his British friend Alexander King in setting up the Club of Rome, which rocked the world with its 1972 report Limits to Growth.158

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Mina Rees. One of the leaders of the Applied Mathematics Division of the OSRD, Rees considered the wartime institutional changes—her part in the construction of which saw her decorated by King George VI—to be central to her organizational worldview. She took these lessons with her to become the chair of the mathematics division of the Office of Naval Research and then of the NSF, ultimately joining Sophie Aberle in gender-integrating the National Science Board in 1964.159

Norman F. Ramsey, Jr. As a young physics student at Columbia, Ramsey won a fellowship to study at Cambridge’s Cavendish Laboratory, where he worked with such crucial luminaries to the subsequent war effort as Ernest Rutherford, John Cockcroft, Ralph Fowler, and Marcus Oliphant. Once the war began, I.I. Rabi recruited Ramsey to cavity magnetron work at Radlab, where his responsibilities included travel to Britain to work with Oliphant on incorporating British developments into U.S. designs. He then moved to the War Department—where he worked for Tuxedo Park alumnus Edward Bowles—and eventually to the Manhattan Project. After the war, Ramsey helped set up the Brookhaven and Fermilab national laboratories.160 Following the launch of Sputnik, in 1958 he was named the inaugural NATO Science Advisor, a position that made him effectively assistant secretary general of the alliance. While there, he worked on organizing

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159 Amy Shell-Gellasch, “Mina Rees and the Funding of the Mathematical Sciences,” *American Mathematical Monthly* vol. 109, no. 10 (December 2002); Oral history interview, Dr. Lee DuBridge and Dr. William A. Fowler with Ms. E. Vernice Anderson and Dr. Judith E. Goodstein, Pasadena, Calif., October 20, 1981, RG307-Stack 103-Row 37-Cpt 15, container 21, NARA. For more on Rees, see this dissertation’s Chapter 5.

educational and exchange programs in Europe, as well as lobbying the heads of member governments of the importance of multilateral R&D programs.\textsuperscript{161}

Caryl P. Haskins. A scientist-philanthropist in the Alfred Loomis vein, the founder of Haskins Laboratories was at the center of the institutional changes wrought by the exchange, having been plucked to be a senior liaison officer for the OSRD in 1941, and becoming executive assistant to Conant in 1943. After the war, Haskins brought this experience to advisory roles for the Army and Navy’s Research and Development Board, the State Department, the Department of Defense, and a series of bilateral science exchanges, particularly with Japan. In 1955 he was named to the President’s Science Advisory Committee (PSAC).\textsuperscript{162}

H. Guyford Stever. One of the young physicists sent to Great Malvern to work as an American exchange partner at the TRE, Stever was profoundly impacted by his tutelage in Britain. The TRE and Radlab experience convinced him that the wartime exchange model was most effective for promoting R&D. As he later argued, “There is one way to do it. Get two people talking. Get an arrangement in which they’re sharing a project, and you get information exchange. In Britain I would watch our visitors walk into a laboratory, and in two seconds they would be diving as deeply as you could imagine into the substance of what they were talking about. That was far and away the best.” Marveling at the “unbelievable cooperation” of the British exchange, Stever carried those lessons

\textsuperscript{161} W.A. Nierenberg, “Project of Report on NATO Science Activities,” December 3, 1963, RG59: Department of State, Bureau of Scientific and Technological Affairs, Central Files, Entry 3008E, box 1, NARA.

\textsuperscript{162} Alice Dadourian, “A Bio-Bibliography of Caryln Parker Haskins,” January 2000, Haskins Laboratories, Yale University, \texttt{http://www.haskins.yale.edu/staff/cph.html}; see also Conant, \textit{Tuxedo Park}. 
forward into the postwar American state, serving first as a member of NACA’s space committee, and later as the director of the National Science Foundation.¹⁶³

Admiral Luis de Florez. In 1941 de Florez took a trip to Britain to study the cutting-edge aircraft simulator technology being developed there. What he learned and reported was so groundbreaking that it led to the inauguration of a new Special Devices Division in the U.S. Navy. De Florez was one of the officers who helped organize the fledgling Office of Naval Research (ONR), which became the single most important agency in translating the institutional and ideological infrastructure of the transatlantic exchange into a permanent postwar bureaucracy.¹⁶⁴ Later, De Florez took these ideas in a decidedly different direction, becoming the first director of technical research for the Central Intelligence Agency in 1954.¹⁶⁵

Captain George N. Robillard. Trained as a lawyer and interested in the promotion of technological development, Robillard spent the war quietly developing a comprehensive patent program for the entire Navy. His efforts helped to reconcile tensions between bureaus and cleared the way for the Radlab vision to move forward in the form of the ONR. Robillard admired the way that Britain had used its Royal Commissions system to spur inventiveness after 1919, and suggested that Congress inaugurate an award scheme using the same procedure. The point, he said, was to focus not...
on narrow legal frameworks, but instead to determine a given innovation’s contribution to national strength. As Robillard argued, in contrast to the U.S. situation, the British state specifically employed people like jet engine pioneer Frank Whittle “to invent or improve”—that was their *job*. “Possibly,” he marveled, “that is why England, with a third of our population and maybe a tenth of our technical personnel and facilities, was ahead of us in many basic military inventions in World War II; and why she was ready in 1940 with the plane types and radar which won the Battle of Britain.” In his role as Patent Counsel for the Navy, Robillard continued campaigning for such state-facilitated invention all the way through 1959, preaching the mantra that “America must invent or die. It is as simple as that.”

The list goes on and on. Alan Waterman, deputy chief of the OSRD’s Field Service—having worked hand-in-hand with the British military in the European theater—became chief scientist for the ONR and then the founding director of the NSF. Gene Sunderlin, Waterman’s first deputy director at the NSF, had also worked in the ONR’s London office. James Forrestal—an obsessive student of British government organization— in the late 1940s, first as Secretary of the Navy and then as inaugural Secretary of Defense, transfused British-inspired ideas into the organization of the new National Military Establishment and National Security Council.

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166 Capt. George N. Robillard, USN, and Beverly Smith, “Are We Stifling the Inventors?,” *Saturday Evening Post*, June 9, 1951; and Draft, Alan T. Waterman, “The Science Record of the ONR,” box 51, Alan T. Waterman papers, LoC.

167 For more on Waterman, Sunderlin, Forrestal, and the legacy of the exchange on the formation of the ONR and NSF, see this dissertation’s Chapter 5.
Perhaps most importantly, the Navy’s Captain Robert Conrad and Admiral Julius Furer sought directly to perpetuate the institutional changes wrought by the war and to move science and technology to center stage in the pursuit of postwar national security. Conrad had been a liaison officer in the NDRC, and Furer a special naval attaché in London. Together, they would institutionalize the Tizard Generation’s new ideas in a Navy-based reimagining of the U.S. technostate.\textsuperscript{168} We will meet them again and see their full impacts—as well as those of Rees, Waterman, Forrestal, and other influential figures—in Chapter 5.

Whether these were people who already harbored a belief in national reorientation toward state science and technology; whether their futurism started in pieces or was fully fleshed out; whether they simply took advantage of a moment and rode a crest, taking advantage of the huge and sudden influx of scientific activity and technological knowledge afforded by the exchange; or whether they genuinely learned to understand the power of centralized state science and the potential of its institutional arrangements from the British, is impossible to fully determine, and is likely to be somewhere in between, regardless. What is certain, however, is that the exchange moment represented a remarkable, and enormously historically impactful, pivot moment for the United States, its technology, and its sense of self as a global power.

The British exchange, in whatever form, set off a chain reaction. It helped give the United States command of important new technologies that would evolve into even more nationally significant ones in the future. The urgency demanded by the development of these technologies

\textsuperscript{168} See this dissertation’s Chapter 5.
helped implant new ways of managing and fostering knowledge in the American state. And the people clustered around these devices and institutions became the vectors of a powerful doctrine that would move to center diplomatic stage in the coming years. This generation made its own direct mark in statebuilding—Stever, to take one example, was still a presidential advisor into the Carter administration—but it also incubated the next generation of technoscience champions. The people drawn into the orbit of the American state and military by the Anglo-American exchange account for much of the Cold War science and technology establishment in the United States, as well as the intergovernmental and international organizations the U.S. came to spearhead. Theirs is a genealogy through which we can trace the concept of technoscience-as-power—back through their institutions, back to the war experience, and, ultimately, back to the British exchange.

The British had had an urgent pair of complementary goals: To use their technologies as diplomatic kindling for an American alliance against Hitler, and to leverage U.S. industrial and scientific capabilities to perfect and produce those technologies. Their surprise and dismay upon realizing that the American government possessed scant few such capabilities provides us with a clear illustration of the ways in which industrialized nations other than the United States conceived of global power by 1940. The British had simply presumed that America’s global industrial leadership would naturally mean a comfortable home in Washington for their R&D offerings, and that a fellow global industrial hegemon would immediately see the value of a gift of secret state technologies. As it turned out, however, the British found themselves scrambling both to foster an American
appreciation for the state command of technology, and to guide the United States on how large-scale institutions for it might be organized. That is the true lesson of Radlab.

With the U.S. now enthusiastically cooperating with their war objectives, the British had proved successful in using science and technology as a geopolitical lever for their own national ends. The idea of strategic enticement through the revelation of knowledge—against which the likes of Tizard and Hill had encountered such resistance in 1939—had worked. But, as we will see in Chapter 2, from the perspective of postwar British industrial interests and technological nationalism, the exchange had also created something of a monster.
Chapter 2: Atlantic Amnesia

As the Tizard Mission wound down and prepared to return to the UK, the delegates noted with satisfaction the sea-change in American state-science that they had helped to bring about, and took solace in the fact that they had mobilized the American industrial machine for British purposes. Tizard’s debriefing noted that “an extensive program of research work” had been initiated during the Mission’s visit, and that it had been able to mold and assist the nature and direction of these projects with the full cooperation of the U.S. military and the “full time services of the best academic scientists of the United States.”

Foreseeing that American science would now “rapidly branch out and amplify,” the British turned to ways their counseling role could be nurtured and maintained. This was the subject of some debate in Whitehall—Tizard’s suggestion for a high-level ministry of exchange was rejected—but soon a series of permanent bureaucratic channels were created as successors to the Mission. The new British Central Scientific Office (BCSO) was tasked to liaise with the OSRD and U.S. government laboratories, while a Combined Production and Resources Board would coordinate industrial output

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1 J.D. Cockcroft, “Memorandum to Sir Henry Tizard on the future of work arising out of the British Technical Mission,” November 25, 1940. AVIA 10/2, UKNA.
2 Ibid.
on both sides.\(^3\) The British, it seemed, had successfully parlayed their scientific advantage into a permanent advisory role on the direction of American science during the war.

But this advantage was to prove short-lived. Powerful American interests were now fully cognizant of the enormous boost the U.S. had accrued from the exchange, and logically sought to press forward to gain any and all new technologies, whether they had obvious import to the war or not. The American state, moreover, was now building unprecedented institutional resources to fully absorb, develop, and distribute foreign secrets to U.S. interests. Embedded in the bureaucratic changes of the war were new mechanisms of U.S. technological power: The lubrication of the wheels of R&D exchange, the organization and funding of laboratories and production units, the coordination of production, and the provision of resources and infrastructure for international joint R&D. In short, by helping to spur the creation of a new R&D machinery in the U.S. state and private industry, the Anglo-American exchange also helped to strengthen America’s capacity to indigenize British technologies, draw nationalistic ideologies from them, and, ultimately, shut Britain out of their postwar developments. The war thus laid bare the complicated relationship between scientific institution-building, the creation of new national security machinery, and the exigencies of diplomatic alliance for the United States. It also exposed the ambiguities of power between this new

\(^3\) Ministerial note, R.B. Stevens, “British Missions in Washington on Anglo-American Exchanges of Information,” February 15, 1946, AVIA 38/1008, UKNA. The BCSO later became the British Commonwealth Scientific Office, and continued operation until the end of the war. Note, however, that it struggled to find influence in a field of exchange crowded by British military attaches and individual Dominion scientific missions. The British insisted that BCSO serve as the central clearinghouse for exchanged information, but as American scientific activity grew and the OSRD London office became more robust, the U.S. had more flexibility to exchange with British and Dominion scientists directly, bypassing the BCSO. For more on this, and the role of the Dominions in facilitating and participating in the transatlantic exchange, see Donald Avery, *The Science of War: Canadian Scientists and Allied Military Technology during the Second World War* (Toronto: University of Toronto Press, 1998), 61-67.
national security machinery and private industry, where the bulk of American technological capacity had traditionally lain.

At war's end, Vannevar Bush delivered a speech with baroque paeans to the mutuality of the Anglo-American exchange, noting that “American and British scientists have worked so closely together that it will be utterly impossible, and a matter of no vital interest, to attempt to assign many explicit accomplishments to one or the other.” But, of course, technological nationalism doesn’t work that way. As we will see, the realities of American production interests, U.S. industry’s pursuit of patent and commercial rights, and the propaganda value of patriotic American technological achievement would conspire to make global technological competitiveness a matter of vital interest indeed.

This chapter’s argument is threefold. First, it contends that the urgency of the British exchange and the haphazardness of U.S. mobilization left legal protections for transatlantic questions of primacy, patents, and intellectual property in fateful disarray. Second, it argues that large U.S. firms maneuvered in and around these ambiguities, using their muscle, their centrality to the war effort, and the ongoing limitations of U.S. state controls, to accrue new technologies to their own commercial advantage. While this industrial evasion of government authority harmed postwar British commercial interests, it ultimately helped set the stage for postwar American trade power and the military-industrial contracting system of the Cold War. Finally, the chapter suggests that as the government’s national security apparatus matured, the state began more aggressively and actively to

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4 Transcript, "Response of Vannevar Bush on occasion of presentation of the Medal of the National Institute of Social Sciences,” New York, May 23, 1945, box 83, Vannevar Bush papers, LoC.
seek benefits from international exchanges like the one with Britain, using the veil of secrecy as an important tool in stemming the outward flow of sensitive information and research. Together, these factors played a substantial role in building up America’s command of critical high technologies, ensuring its commercial and strategic preeminence, and constructing its self-conception as a technological hegemon.

Dire straits

Despite earlier posturing of confidence and technological superiority, it was no secret in the U.S. that Britain was in a desperate situation indeed. In September 1941, for example, the Royal Navy found itself in such dire straits that it asked the NDRC to send Americans to the UK in order to take scientific secrets away more quickly. As one attaché pleaded, the shortage of British technical personnel in the micalex industry in particular was so acute that no workers could even be spared for the amount of time required to bring information to the United States. It would thus be “highly desirable if some competent American technical person could be sent over here to learn the details of the manufacturing process and that he then be sent back to the U.S.A. to supervise permanently the technical operation.”

As time went on, the primary node of exchange shifted from British missions in Washington to the new OSRD London office, carved out of a suite in the U.S. embassy, which was better able to siphon and redistribute the latest British developments directly from their sources. Significantly, this

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5 Letter, Frank D. Lewis, NDRC Mission London, to Carroll L. Wilson, September 26, 1941. OSRD, Records of the Liaison Office, RG227, Entry 168, Box 7, NARA.
was the first time the American state had ever placed an official scientific attaché mission in a foreign capital.\textsuperscript{6} By war’s end, OSRD London had sent tens of thousands of technical reports back to Washington, and had developed a lauded reputation for being able to dash information on “hot” advancements to American officials well before stateside administrators were even aware of their existence.\textsuperscript{7}

As British research and knowledge became processed and absorbed by the growing U.S. science apparatus, and as original scientific concepts were elaborated for application and put into large-scale production, they also began to be slowly indigenized as \textit{American} R&D in the minds of both scientists and officials. During the war, this was for practical reasons. By 1942, there was substantial duplication of research effort on either side of the Atlantic, particularly in advanced technologies like radar. Little attempt was made to divide labor between allies in a complementary way, and instead a system arose whereby both nations conducted parallel research and then shared the results, for mutual benefit. Dr. Ralph Bown, of the NDRC Microwave Committee, noted that this was an “inevitable” approach, given the strategic interests of the two nations. Complementary division of research during wartime would be a hazardous strategy—the U.S. could not afford to rely


\textsuperscript{7} In addition to personal liaisons with scientists and academics by American “leg men” in Britain, the OSRD London mission received regular reports from the following British agencies: Ministries of Supply, Home Security, Aircraft Production, and Production; the T.R.E. [under the MAP]; the Central Radio Bureau of the MoP; the Admiralty; the Coordination of Valve Development; DSIR; the Petroleum Warfare Department; and the Ordnance Board. Letter, “Re: Dizzy pace set by London Mission,” William A. Shurcliff to Bennett Archambault, August 6, 1943, OSRD, Records of the Liaison Office, RG227, Entry 169 (NC-138), Box 48, NARA; and Report, Eugene W. Scott, Assistant Liaison Officer, to Homer Jones, Foreign Economic Administration, March 15, 1945. OSRD, Records of the Liaison Office, RG227, Entry 169 (NC-138), Box 41, NARA.
on Britain as long as a Nazi invasion was plausible, for fear that a sudden cutoff of British expertise would torpedo important developments. And Britain, despite having carefully edged its way into a counselling role in Washington, could not trust that the U.S. would always continue to work for British interests, especially after Pearl Harbor.⁸

Thus, as the OSRD and other American R&D outlets mushroomed, and as massive volumes of powerful new technologies emerged from U.S. institutions like Radlab and manufactories like GE, easy recognition of where given innovations had originated began to diminish.

Of course, it was to both sides’ immediate wartime benefit—and to American science’s long-term benefit, knew shrewd operators like Vannevar Bush—to have the American state fully engaged in these problems. But the hurried and improvised way in which the cooperative relationship was constructed eventually proved problematic for postwar British interests. Although American officials like Bush, Knox, and Roosevelt entered the exchange in good faith, the rapidity with which American state-science mechanisms were cobbled together ultimately failed to provide an adequate legal and bureaucratic framework for considerations of scientific primacy. More damningly, the urgency and anxiety that had guided British leaders’ actions in the early years of the exchange forced them, too, into a reluctant position of willful neglect toward their own protections and rights. This opened the door for U.S. industry to appropriate Britain’s most valued secrets, intentionally or otherwise. The Allies may have triumphantly rolled through the ruins of Nazi Germany together in May 1945, but

decisions taken in Whitehall during the desperate hours of May 1940 would nevertheless haunt British industry for years to come.

**Patent absurdity**

One of the main flashpoints was in the matter of patents. As we have seen, war and production agencies from both the U.S. and Britain pursued the exchange with no holds barred— their main priority was technological, not legal. But their respective national industries were more wary. Private British firms whose research was being released to the U.S. were barred from filing for international patents due to the secret nature of the information being given, and in some cases tried to hold back trade secrets out of fear of competition. And U.S. manufacturers were reluctant to produce British inventions because they feared postwar patent claims and lawsuits from UK firms, as had happened after World War I.\(^9\) Neither the international patent system nor the U.S. government had a sufficiently flexible or robust legal framework to address these issues.

In light of this shortcoming, the British initially placed basic release conditions on all secret information, assuming that the respective governments would negotiate individual contracts with both inventing and manufacturing firms on given innovations. But this didn’t account for the sheer volume of the exchange—Britain was giving *everything* away, and the bid to use the Mission to draw the U.S. closer had been so wildly successful, and was resulting in such volumes of information being exchanged—often in informal ways—that it was essentially impossible for any agency even to keep

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\(^9\) Memorandum, by J. Foster to Sir Henry Tizard, September 26, 1940, UKNA, AVIA 10/2; and Memorandum, K. E. Shelley, K.C., July 19, 1941. UKNA, AVIA 10/129.
track of what had been given by whom, much less enter into negotiations for each item. The
overwhelming prevalence of private contracting by the U.S. military, moreover, required a large
transferal of secrets from British commercial firms directly to their American competitors once the
exchange got underway. As a result, the Tizard Mission was forced to accept that the new “normal
practice,” at least in the early stages, would be for manufacture to go forward with or without
settlement on terms of compensation.10

These problems were not unforeseen. Henry Tizard, in his very first London meeting after
returning from America, had warned that the transferal and manufacture of commercially secret
information overseas would present legal difficulties.11 But the urgency of the need to exchange
research and commence production overrode the impulse for careful legal prudence on intellectual
property matters. The purpose of the mission, after all, had been to leverage scientific secrets in
return for hard materiel and closer cooperation; delays while seeking legal assurances would only
negate the mission’s importance to the war effort.12 Moreover, Americans were beginning to apply
pressure on the British to defer all such questions of legal rights. Navy secretary Frank Knox twice
wrote to the British Purchasing Commission to argue in no uncertain terms that commercial rights

10 Memorandum, by J. Foster to Sir Henry Tizard, September 26, 1940, UKNA, AVIA 10/2.
11 “Notes of a meeting in connection with Sir Henry Tizard’s mission to America (1940), held at the Ministry of
Aircraft Production,” October 14, 1940. UKNA, AVIA 12/246.
12 Tizard was repeatedly assured by U.S. military personnel that, at the very least, records would be kept which could
be used later to establish primacy of invention, although this proved both impractical and legally inadequate as the
volume of exchanged information increased. Nevertheless, at this early stage speed in starting production was
considered paramount by British officials and by the U.S. military, and Tizard wrote to London that “it will be
generally agreed that all delay should be avoided. I hope, therefore, we shall be prepared to take risks in the United
States, relying on the good faith of all concerned.” Sir Henry Tizard, “Note on the Manufacture of British Secret
Equipment in the United States,” November 7, 1940. UKNA, AVIA 10/2.
could not be safeguarded under the present system, and that while they would eventually be taken into consideration, this should not be “to the detriment and hindrance of the measures being undertaken for the national defenses of the British Empire and the United States of America.”

The result was a winking neglect of legal matters by science administrators on both sides, a circumstance that would work to the benefit of the U.S. and detriment of the UK as the war went forward. Liaison officers and science officials were cognizant of the patents issue, and when pressed proposed vague arrangements to satisfy the nations’ separate interests, like empowering a patents arbitrator to settle any claims. But this was merely an example of science officers’ priorities being technology and production, rather than international law. The scientists simply assumed—or said they did—that lawyers and negotiators would eventually overcome the legal impasse. As Karl Compton, then in charge of the OSRD’s radar division, wrote, “We have been inclined, I think quite properly, to consider [patent rights] as of very secondary importance and to follow the policy of not permitting the consideration of patent rights or trade advantages to slow up in any way the prosecution of the defense effort.” And as the British Air Commission’s Capt. Leslie Douglas-Mann admitted, pending something formal, “both governments are acting upon the assumption that the general principles of the Agreement are already in force; and the exchange of manufacturing information, for war production purposes, free of royalty liabilities, is proceeding accordingly.”

13 Letter, Secretary Frank Knox to British Purchasing Commission, October 30, 1940; and Letter, Secretary Frank Knox to British Purchasing Commission, January 9, 1941; UKNA, AVIA 10/129.
14 Letter, Karl T. Compton to Carroll L. Wilson, August 14, 1941. OSRD, Records of the Liaison Office, RG227, Entry 168, Box 22, NARA.
British industrial knowledge, in fact, had been furnished “on a royalty-free basis, from time to time, ever since the passing of the Lend-Lease Act.”

In legal reality things were not so simple. A small cadre of patent counsellors, legal advisors, solicitors, and committees were convened by both governments to wade through the entanglements of the exchange, and to turn nebulous verbal confirmations and informal agreements-in-principle into a binding legal basis for what was already becoming an administrative nightmare. This task was made more difficult by the diversity of interested and uncoordinated parties in the U.S.—the Departments of State, War, and Navy; the Lend-Lease Administration (OLLA); the Board of Economic Warfare, and others. Meanwhile, the OSRD, Bureau of Ships, and Chief Signal Office negotiated a separate information-pooling scheme, known as Company A/B, whereby firms officially designated by each government—among them GE, Westinghouse, Bell Telephone Laboratories, Metropolitan Vickers, EMI, and Marconi—could voluntarily share research with each other directly, without routing it through state channels. The exchange was, in short, bureaucratic bedlam. The one constant was that enormous volumes of secret information continued to flow across the ocean unhindered.

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15 “Memorandum by Capt. L.J. Douglas-Mann for the Director General, B.A.C., in regard to negotiations between the U.K. and U.S. Governments,” April 26, 1942; UKNA, AVIA 10/129.

16 Initial Anglo-American discussions on Company A/B occurred in April 1942; it was negotiated and pitched to firms through the summer, and began operations on September 1 including a provision to retroactively pool information dating from March 1. The Plan remained in effect—and effective—for the duration of the war. Report, Albert F. Coleman, “History of Radar Exchange (Company A/B) Plan, 1940-1945,” Liaison Office, OSRD, January 1946, OSRD, Records of the Liaison Office, RG227, Entry 168, Box 8, NARA; and Navy Department memorandum, “Company A/B Plan – Suggested termination of,” Office of Naval Research papers, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 12, NARA.
Official negotiations between governments, meanwhile, remained slow and fruitless until late 1941, when the OLLA began to apply political pressure on other American department heads to resolve the legal issues of the exchange. This pressure, as well as bureaucratic persuasion from War Secretary Henry Stimson, led in August 1942 to the signing of a draft Patent Interchange Agreement, but this, too, generated difficulties. The PIA called for American legislation to be enacted to safeguard UK inventors’ rights, but as of 1944 this had still not been accomplished. British negotiators like Lloyd Jacob of the Radio Board hoped to secure amendments guaranteeing British firms a grace period of six months to file claims in the U.S., but three successive bills drafted by the American Patent Office did not meet these requirements. Moreover, the special committee that the PIA set up in Washington quickly proved inadequate, since it failed to take up the most contentious legal problem in the exchange: “the inferior legal powers of the U.S. Government over their firms.”

In the view of the solicitor for the British Treasury, the Crown possessed the power to authorize manufacturers to use patents for emergency purposes, licenses notwithstanding, with the result that any future intellectual property litigation would theoretically be brought against the government, rather than the ‘borrowing’ manufacturer. The U.S. government, he argued, possessed no such powers, and therefore could not stand as a legal shield between lawsuits from British patent

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17 Assistant Controller (R&D), “Exchange of Technical Information with U.S.A., Proposed Statement of Position and Admiralty Policy,” September 20, 1944; and Draft Interim Report, Interdepartmental Committee on Safeguarding Post-war Rights in Inventions, 1944; UKNA, BT 305/3; and Memorandum, L.J. Douglas-Mann for Director General, B.A.C., “In regard to negotiations between the U.S. and U.S. governments on the subject of the free use…,” April 26, 1942, UKNA, AVIA 10/129.
holders and the American manufacturers making use of them.\textsuperscript{18} This led to understandable hesitance on the U.S. side, and no clear way to resolve it. As British negotiators like Douglas-Mann bemoaned, the weakness of the U.S. government was “the root of all the trouble.” Not only did the American state have no powers to intervene in industrial matters, they said, but “nobody dares to ask Congress to supply them.”\textsuperscript{19}

Actually, negotiators \textit{had} managed to agree on a scheme whereby both nations’ legislatures would pass harmonized bills providing firms indemnity from foreign lawsuits, but on the American side the path through Capitol Hill was predictably tortuous. When H.R. 5534 was introduced to the House of Representatives in August 1941, it failed to pass. With further pressure from the War Department and Lend-Lease Administration, Congress took up another bill, H.R. 7299, in 1943. Britain’s version was approved by Parliament without trouble, to come into effect once its U.S. counterpart did, but political wrangling altered the American bill’s provisions beyond recognition, omitting many of the key points negotiated with Britain. Even if it had passed, Parliament would have had to return to the drawing board in Westminster to try to alter the British bill to align it with the Congressional one. British negotiators became exasperated, complaining that the delay was

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\item \textsuperscript{18} “Note by the Treasury Solicitor on the Legal Issues Raised by B.A.C. Telegram Briny 5643,” (June or July 1941), AVIA 10/129, UKNA. For more on secret patents in Britain, see T.H. O’Dell, \textit{Inventions and Official Secrecy: A History of Secret Patents in the United Kingdom} (New York: Oxford University Press, 1995).
\item \textsuperscript{19} Letter, L.J. Douglas-Mann, British Air Commission to P.H. Goffey, Esq., Ministry of Aircraft Production, June 24, 1943, UKNA, AVIA 10/129. Note that, later, the President’s executive authority under the Second War Powers Act (March 1942) gave the Secretary of Commerce the authority to make secret patent applications available under any conditions he deemed appropriate. But this still did not provide for reciprocal indemnity, nor did it allow for a blanket transfer of secrets to the Army and Navy (that is, the War and Navy Departments received secret patents not from the Patent Office but from the inventors themselves, which further prevented a blanket arrangement with the UK). Minutes, Joint meeting of the British-American Patent Interchange Committee held at the Office of the Lend-Lease Administration, December 31, 1942, UKNA, AVIA 10/129.
\end{itemize}
“beginning to hamper the war effort seriously,” as mistrustful American firms refused to allow production in Britain until they were protected from lawsuits. In the absence of legal recourse, British officials did their best to offer informal resolutions. In the words of the British Embassy in Washington, “where they can, the British authorities are according the necessary protection to American applicants as if the reciprocal protection existed.”

This is not to say that British firms were simply charitable. The British government, too, had complications in coaxing its intellectual property holders to give away their secrets. But firms were convinced, it seems, by the earnest intention of government negotiators to solve the bilateral patent problems, even if the results weren’t immediately obvious. British officials made serious and complex proposals to ensure that corporations and inventors would be awarded Royal Commissions, and vowed to set up special tribunals if necessary to make sure property rights were respected. They pressed their case in good faith at the highest levels, drawing the U.S. military secretaries personally into the issue. The windfall of Lend-Lease also had a salutary effect on British firms’ thinking. As a result, by January 1941 all but a handful of UK licensors agreed to transmit their information to the U.S., confident to leave the nitty-gritty legal wrangling to the governments, in whose hands they assumed they were secure. As the Ministry of Aircraft Production concluded, “in general we should expect most UK licensors to agree readily as regards manufacture in the U.S. for the UK government.

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20 Aide memoire, British Embassy, Washington D.C., May 19, 1943; and Letter, Henry Stimson to Honorable Sir Clive Baillieu, September 18, 1941, UKNA, AVIA 10/129.
Some licensors have already agreed that prices of U.S. manufacturers shall be exclusive of royalty and that terms be settled between the licensors and us.”

Given the cooperative instincts of top administrators on both sides, as well as the relatively smooth fashion with which they overcame myriad other difficulties, it may seem surprising that the matter of intellectual property remained such a problematic one for so long. And it is doubly surprising in light of the fact that the parties most likely to be disadvantaged—British science agencies and commercial firms—were committed fully to the exchange and had effectively waived most of their legal rights. What, then, drove years of wrangling, negotiations, and hindrances? As we will see, the central complication was the obstinate stance of self-interested U.S. corporations, compounded by the American government’s inability—sometimes for legal reasons, sometimes for political ones—to coerce firms into war cooperation beyond offering simple fiscal incentives.

Although commercial propaganda during the war and afterwards painted a rosy portrait of industry and citizenry selflessly working hand-in-hand to defeat fascism, in reality the commercial side of the effort was less about patriotism than about firms recognizing that the wartime government’s enormous contract expenditures were good for business. There was nothing automatic about industry’s cooperation with government, even in wartime—business leaders had held the Roosevelt administration in suspicion since the New Deal, after all, and their hostility to the White

21 Letter, Frank Knox to British Purchasing Commission, Washington, D.C., January 9, 1941; Memorandum, Ministry of Aircraft Production to British Embassy, Washington, November 16, 1940; Memorandum, Ministry of Aircraft Production to British Air Commission, Washington, January 10, 1941; Memorandum, British Air Commission, Washington to Ministry of Aircraft Production, June 3, 1941, AVIA 10/129, UKNA.
House even surprised the Tizard Mission when it arrived.\textsuperscript{22} From Pearl Harbor to VJ Day, firms continued looking for beneficial loopholes, and balked—even rebelled—when they didn’t feel their interests were being served.

Leaders in Washington knew this. Unlike in Britain, where industry had functionally become an arm of the wartime government, American officials at every step were compelled to carefully massage relations with industry in order to keep the war machine running. In the days immediately following Pearl Harbor, for example, military leaders tried to encourage firms involved in radio research to set up “pools” to share information with each other for more rapid development. Despite the emergency, however, the officers behind the initiative—Major Robert Patterson of the War Department (later Secretary of War) and Colonel Conrad Snow of the Signal Corps—were nevertheless compelled to call a meeting with industry leaders to assure them that government was hesitant to ask for any exchange without an eye to the protection of commercial rights, and to promise them that the pools would be on a voluntary basis only.\textsuperscript{23} A year later, in a high-level meeting to hammer out the Anglo-American patent agreement, Navy commander Richard Spencer noted that since relations with U.S. industry were sensitive, government parties should avoid


\textsuperscript{23} Minutes, “Summary of the discussion at the meeting at the office of the Under-Secretary of War,” December 9, 1941. OSRD, Records of the Liaison Office, RG227, Entry 169 (NC-138), Box 46, NARA. Note that the minutes refer to Patterson only as “Major Paterson [sic] of the Under-Secretary’s office.”
mentioning postwar patent rights entirely unless brought up by firms themselves, as the issue would only further slow the procurement of vital technologies.24

Such caution was required because conservative elements remained poised to pounce on any initiatives—wartime or not—that smacked of governmental overreach. Thus, even the military shied away from any appearance of coercion toward large firms, or of bullying toward smaller ones. In one notable case, the Navy tried to groom the disastrously mismanaged minor aircraft firm Brewster Aeronautical into more efficient aircraft production. After a series of botched designs, production failures, illicit strikes, fraudulent arms shipments, and even suspected sabotage, the company was temporarily seized by the Navy, which tried to rationalize production of its F31-A Corsair fighters for battle use. But even in these calamitous circumstances conservatives cried foul. Business leaders like National Association of Manufacturers president W.D. Fuller, and politicians like the conservative Senator Robert Taft, claimed that even temporary nationalizations meant that “Hitlerism wins,” and that such business seizures were akin to Nazis shooting hostages in France.25

Big businesses possessed the leverage to pressure officials to safeguard their interests, and to refuse contracts point-blank if they weren’t satisfied. British officials on the receiving end of this brinksmanship often howled that, despite all of their own secret disclosures, some American firms still refused to release vital war research to the UK on the grounds of insufficient patent protection. Moreover, even after lengthy negotiations, some U.S. firms adopted the strategy of releasing

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24 Minutes, Joint meeting of British-American Patents Committee, Office of Lend-Lease Administration, November 12, 1942, UKNA, AVIA 10/129.
information “for experimental purposes only,” meaning British production of vital war materiel was functionally prohibited. In one episode, the Chrysler Corporation refused a request from London for secret information until the U.S. Patent Office’s secrecy provisions were amended. By way of compromise, a byzantine solution was worked out whereby Chrysler provided the information to the U.S. Army, which was permitted to transmit it to Britain if the British Air Commission filled out a Lend-Lease requisition order, despite no payment being involved.

Considering their overall diplomatic goals of rapid mobilization and massive production, scientists and officials in Britain were frequently driven to distraction by the obstinacy of American industry. As early as the summer of 1941, some researchers transmitting data to the U.S. began to grow wary of an exchange that increasingly seemed like a “one-way proposition.” In June, Richard Whiddington, a leading British expert on valves and electronics research, angrily approached the NDRC London mission asking, since Britain’s commercial firms had already given away their data freely, “why in the hell [are] U.S. firms not reciprocating[?]” If this lack of sharing continued, he warned, British firms would have understandable second thoughts about continuing to send their information to the U.S.

Accordingly, British state actors—for whom the stakes were undoubtedly higher than those of the United States, particularly early in the war—fumbled for strategies to keep the exchange afloat by

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26 Aide memoire, British Embassy, Washington D.C., May 19, 1943, AVIA 10/129, UKNA.
27 Minutes, Joint meeting of the British-American Patent Interchange Committee held at the Office of the Lend-Lease Administration, December 31, 1942, AVIA 10/129, UKNA.
28 Letter, Carroll L. Wilson to Dr. W.L. Webster, July 14, 1941, OSRD, Records of the Liaison Office, RG227, Entry 168, Box 9, NARA.
coaxing U.S. firms into giving as well as receiving. The British Air Commission, exasperated by industrial hampering of the war effort, even proposed that the British Parliament legislate an act prohibiting UK patent holders outright from seeking claims against U.S. manufacturers, and instead requiring the British government to pay any and all potential damages. As one solicitor noted, such a law would be costly for the British taxpayer, “but the cost will be trifling compared with the advantage to be gained by removing the existing reluctance of U.S.A. manufacturers.”29

On top of predictable ideological conflicts between American government and business—much of which was merely touching nerves already made raw by the New Deal—the nature of the improvised wartime science apparatus itself also provided new opportunities for exploitation and manipulation. Particularly in the case of the OSRD, the very same factors that had allowed R&D activities to ramp up so quickly also led to a mushrooming system of expenditure and contracting that quickly spiraled out of control, in both a political and regulatory sense. As Larry Owens has shown, the prewar conservatism with which Bush imbued the OSRD led to a lax system of “associationalism” in funding private science contracts, rather than providing centralized oversight. This successfully encouraged buy-in and cooperation from academia and industry, but made reining in snowballing projects nearly impossible in the later war years.30

More directly, such rapid institution-building as had created the OSRD generated a contradictory arrangement whereby the U.S. government successfully formulated a smooth, well-

29 Memorandum by K.E. Shelley, K.C., July 19, 1941, AVIA 10/129, UKNA.
oiled mechanism for transferring British secrets directly to American firms, while failing to provide corresponding regulatory barriers against those firms seeking to profit from the innovations received. To make things worse, in many cases, wartime security preoccupations pushed U.S. officials to prioritize domestic secrecy over mutual cooperation with Britain. Unintentionally or not, this prioritization nevertheless worked to secure the interests of American firms, both during the war and afterwards. This was true for several of the core technologies to emerge from the war—the jet engine, penicillin, and even early atomic weapons research among them. Each of these provides a case study in which initial data was moved from Britain to U.S. firms through state channels, quickly indigenized and developed in the U.S., and then shrouded in security restrictions to prevent foreign disclosure. After the war, this walling-off translated directly into transatlantic commercial rivalries and military-scientific arms races.

A brief look at the trajectory of one of those crucial wartime advancements—penicillin—provides an archetypal case study of these dynamics in action.

**Mold money, mold problems**

The process of purifying and synthesizing penicillin—the first true antibiotic—was developed by Lincoln College, Oxford fellows Howard Florey, Norman Heatley, and Ernst Chain, who conducted the first clinical trials in 1941. Similar to the dynamic that had spurred the Tizard Mission, in the early stages of the war the British pharmaceutical industry found itself overburdened and unable to divert precious resources toward producing what was then an experimental drug. The Rockefeller Foundation encouraged Florey and Heatley to seek support in the United States, where
they came to the attention of both Vannevar Bush and OSRD medical chief Alfred Richards. With this high-level backing, Heatley began intensive work at the Department of Agriculture’s North Regional Research Laboratory (NRRL) in Peoria, Illinois, and Florey shopped the new drug to representatives of the American pharmaceutical industry. Shortly after U.S. entry into the war, Merck & Co. committed to the project, promising the OSRD a batch of synthesized penicillin by New Year’s Day, 1943.31

In Peoria, Heatley was tasked to work with Dr. Andrew J. Moyer, a molds expert, and together they began experimenting with a fermentation process using a broth of corn steep liquor and lactose. This “deep culture” process allowed the strain to grow throughout the medium, rather than only on the surface, thus increasing the ultimate production volume by many orders of magnitude. The process proved wildly successful, and a patient with streptococcal septicemia was treated with drugs made via the new method in March 1942. But Heatley began to find Moyer a difficult and secretive research partner. The reason for this became apparent only after he had returned to Oxford—Moyer published their research under his own name, omitting Heatley’s contribution from the paper, and thus from the four patents he was subsequently issued.32

This was considered abhorrent in Britain. While British law had curtailed chemical patents on food and medicine in the aftermath of the First World War, to the science community the

claiming of private rights over a public good was also a matter of ethical conviction. The patenting of a vitamin D enrichment process in the 1920s set off a yearslong professional debate among British scientists about the “dangerous precedent” of privatizing the “laws of nature,” especially if they possessed the power to save lives. In 1931 a strong majority of the British Medical Association voted that it was wrong to restrict medical discoveries for “personal advantage,” and the Medical Research Council called—in vain—for an international treaty to ban such patents.33

Back in the U.S., the importance of penicillin was realized from an early stage, and enormous energy and funds were quickly marshalled into the drug’s development for war use. As in all other areas of the Arsenal of Democracy, this meant tapping into the resources of America’s industrial behemoth. At the corporate level, Merck was joined by Squibb, Pfizer, and Lederle, who were gifted enormous legal, financial, and infrastructural advantages in developing the drug by the American wartime government. Two parallel programs went forward, one to ferment the naturally occurring bacillus, the other to try to devise a synthetic version. The latter scheme, too, was first accomplished in Britain, with Oxford chemist Dorothy Hodgkin successfully modeling it in 1945. Despite a thousand scientists and significant corporate funds being dedicated to it, however, the synthetic program proved a failure for wartime use, and the natural fermentation process won out.34

34 John Patrick Swann, “The Search for Synthetic Penicillin during World War II,” British Journal for the History of Science 16:2 (July 1983), 159. Separately, Bud (“Upheaval in the Moral Economy of Science?”) argues that the sprawling requirements of penicillin development created working conditions that challenged established ethical and procedural norms in medical science, thus accelerating the shift to private exploitation of pharmaceuticals. As he writes, “Meeting the challenge of researching, producing and isolating large quantities of penicillin had been hard.
The War Production Board devised a corporation-friendly system for mass manufacture, funding the construction of pharmaceutical factories and then selling them to industry at a considerable discount. The WPB also funded antibiotic research at Stanford, Penn State, the Universities of Wisconsin and Minnesota, and Cold Spring Harbor, but subsequently turned most of their findings over to industry without conditions. Government bought all production-line penicillin at cost-plus prices, which made the drug enormously profitable for firms. In the midst of this windfall, the OSRD debated ways to compel (or, at best, incentivize) firms to submit their discoveries as they became available, convinced that companies would withhold essential information. Those fears were not unfounded: while the OSRD’s Committee on Medical Research (CMR) provided a clearinghouse through which companies could share research, Merck and their competitors maintained their commercial motivations throughout. As one industry insider ostensibly tasked with sharing results remembered, “My job… was to go from one plant to another collecting honey, but I was not to distribute pollen along the way.”

From the British perspective, the industrial secrecy surrounding penicillin gave lie to prior paean to mutual effort and cooperation. Despite the OSRD adding the CMR to its London office in

Both approaches had involved practitioners of several disciplines and required them moreover to work together, an experience most of them had never had. This experience had challenged the normal norms of academic life: reward structures, what constituted understanding and adequate evidence, trust and the role of publications.”


order to better facilitate Anglo-American exchange, military security restrictions were placed on all aspects of U.S. penicillin production from March 1942, effectively sealing Britain off from further development. A perplexed Florey joined British representatives in industry and government in complaining that despite having made all research available to U.S. firms, it was now impossible to receive any information in return.\(^37\)

Ultimately, with two war theatersraging, the priorities of American authorities like Bush were centered on overcoming domestic hurdles to get penicillin onto the battlefield as quickly as possible, not on safeguarding British property rights. In particular, the Americans concentrated their legal resources toward overcoming federal antitrust regulations, since the OSRD needed domestic industrial research on the drug to proceed as a joint corporate venture without running afoul of antimonopoly statutes.\(^38\) Patent “pools” among U.S. firms were anathema in the New Deal-tinged American justice system, let alone between U.S. and foreign ones. Indeed, as victory inched closer the Justice Department became less shy about prosecuting what it saw as cartel arrangements. Antitrust head Wendell Berge filed suit against DuPont and ICI in January 1944, citing “the cartel system

\(^37\) Brown, *Penicillin Man*, 158; and Memorandum, RAFDEL, Washington, to Air Ministry, Whitehall for JAS, July 1, 1944, CAB 110/73, UKNA.

which has plagued us with shortages of critical material, lack of know-how and industrial skills during war.”39 Transatlantic interests became a casualty of the altered priorities of war.

Separate research in the U.S. thus continued apace under the blanket of security. When the Ministry of Supply sent representatives from Glaxo and ICI to the U.S., they immediately saw the superiority of the deep fermentation method for mass production, but the Americans—following Moyers—considered that process proprietary to the United States. When attempts to obtain information on the deep culture process were rebuffed, Glaxo, Distillers, and the new British penicillin consortium Therapeutic Research Corporation were thus compelled to purchase licenses for the technology from Merck, Squibb, and Pfizer.40 This licensing, however, did not include engineering or commercial “know-how,” thus opening another avenue for industrial conflict after the war.41

It was not only knowledge at stake. Concentration of production also allowed the United States to control access to the global supply of the drug itself, and American industry sought to keep it that way. A dispatch from the Ministry of Production reported rising resentment over British

40 Brown, *Penicillin Man*, 158; and letter, Connor to Bush, October 28, 1952. The TRC had been formed by British Drug House Ltd, Glaxo Laboratories, May & Baker Ltd, Boots Pure Food Company, and the Wellcome Foundation. After the war, the consortium became a central node of controversy over the issue of primacy in penicillin development, as American legal representatives argued that the latterly-formed TRC had no legal right to claim patents on advancements developed earlier by its constituent firms, and should not be considered a single entity for the purposes of patent rights. “Statement of Case, Submitted by the Therapeutic Research Corporation of Great Britain Limited to the Medical Research Council, on the Anglo-American Penicillin Agreement of the 25th January 1946;” and Letter, A. Lansborough Thomson to Chairman, Research and Development Board, Washington, D.C., March 29, 1950, FD 1/5341, UKNA.
penicillin manufacture among U.S. firms, who believed that they alone could and should “satisfy the needs of the whole world, especially after the war.”

American control became a political problem as production grew large enough to allow for civilian use, rather than just combat. In 1944 the Foreign Economic Administration, a new overseas distribution agency led by the boisterous Leo Crowley, banned Allied nations from purchasing penicillin except through U.S. commercial channels, breaking from the precedent of distributing it through Lend-Lease. The British were incensed. The Colonies Supply Mission complained that the FEA had “shown the cloven hoof,” while the Ministry of Supply scrambled to find ways to increase domestic production. As British ministers saw it, the UK should not be indebted to American firms for what they considered to be an essentially British technology. Under pressure, the FEA backed down from its stance, but the writing was on the wall for Anglo-American cooperation in antibiotics.

In light of these difficulties, British ministers conceived a scheme of ramping up their own commercial production for civilian and colonial use, while continuing to import American supplies for the military. This was justified, they believed, by the fact that penicillin was “a British discovery which we have made available free to America.” But this move was unacceptable to the Americans, particularly given the precedent set by the White Paper of September 1941, which had informally

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42 Letter, Sir Nigel Campbell to Secretary, Ministry of Production, June 12, 1944, CAB 110/73, UKNA.
44 Minute, Lord Moore (?) to Secretary, June 15, 1944, CAB 110/73, UKNA.
guaranteed that Lend-Lease articles would not enter commercial channels in Britain or elsewhere, even indirectly. The British thus found themselves in a scientific and legal bind.

Victory in Europe sounded the death knell for British attempts at reclaiming any original rights over the penicillin discovery. Merck filed for patents in Britain on the submerged-culture process in 1944, and engaged in legal rights battles with Distillers Ltd, ICI, and Commercial Solvents until 1952, when the British firms conceded to paying a lump sum for manufacturing licenses. Commercial Solvents also purchased Moyer’s patents. Merck’s general attorney (and later president) John T. Connor responded to British accusations of malfeasance by insisting that “not a shilling” had been paid by British firms for royalties, but this was careful diplomacy—in reality the licenses were royalty-free, but instead required the firms to pay Merck a percentage of net sales.

Ultimately, the steadfastness of British opposition to paying U.S. firms for penicillin rights meant that for corporations like Merck and Pfizer, attempting to compel payments became more trouble than it was worth, and in many cases they did not press the case. Instead, they found enormous revenue from such alternative sources as charging for production “know-how” that was outside the boundaries of patent disputes.

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47 Bud, “Upheaval in the Moral Economy of Science?”
The issue of penicillin would rankle officials from both nations for decades. When Harvard president James Conant delivered a speech in London in 1952 extolling penicillin as a “joint adventure among scientists on both sides of the Atlantic, [in which] the wraps of secrecy are removed… a truly international undertaking,” he promptly received a prickly letter from Oxford fellow E.M. Hugh-Jones complaining of the “unethical” way the Americans had betrayed the honor system of the exchange, and detailing the ways in which U.S. firms had monetized British research.⁴⁸ An incensed Vannevar Bush, himself now a member of the Board of Directors at Merck, shot back that American firms were not unique in being self-interested, and that “the British tendency to call us robbers annoys me considerably.”⁴⁹

Regardless of personal affronts, there is little doubt that the wartime penicillin exchange revolutionized American medicine, garnered enormous profits for the pharmaceutical industry, and provided the U.S. with a key technological platform for the projection abroad of national strength, innovation, and benevolence during the Cold War.

Most immediately, the drug itself was profitable, particularly given the enormous volumes of government purchasing, as well as the subsidies for development and facilities. Penicillin was a wonder drug that dramatically slashed troop mortality rates, and government wanted as much of it produced as possible, as quickly as practicable, with little regard to antimonopoly considerations or

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cost. In the view of Bush, penicillin “put more men into combat service in this war than the entire number of personnel engaged in all research for military purposes in the country,” mostly as a result of its ability to rapidly cure gonorrhea.50

But the drug also served as a critical springboard for industry, as the data and R&D expertise acquired during the war ensured American domination over the maturing antibiotic field. Thus, when the government lifted its restrictions on the civilian supply of penicillin to great publicity and fanfare in March 1945, American companies were automatically years ahead of the rest of the world in what was already recognized as an epochal new industry.51 U.S. firms immediately came to monopolize the natural antibiotic market, which for nearly three decades after the war comprised 25 percent of the entire worldwide drug market.52

Beyond profits, the wartime trajectory of penicillin gave unprecedented status to the American pharmaceutical industry, and helped to make the U.S. a global biomedical hegemon in the decades ahead.53 As chemical industry historian Basil Achilladelis has argued, prior to the war the

50 “Proceedings of Conference to Consider Needs for Post-War Research and Development for the Army and the Navy,” April 26, 1944, Room 3601, Navy Department, Washington, D.C., p. 24, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
51 Alexander Fleming even embarked on a world tour in 1945, where he was hailed as a medical savior in most places he visited. See Brown, *Penicillin Man*, Chapter 9. Fleming, Florey, and Ernst Chain shared the 1945 Nobel Prize in Medicine, although this had no bearing on the advantageous position of the U.S. penicillin industry.
53 Scholar Ilana Löwy notes that penicillin represented a key turning point in the process of “biomedicalization,” or the “scientific turn” of doctors—the bringing together, that is, of practical medicine and laboratory science. “Biomedicine” itself was an interwar coinage, and came into its own following penicillin’s successful confluence of biology, clinical practice, and industry. We may perhaps take it as a medical parallel to the professional, conceptual, and bureaucratic convergence described above in the creation of Radlab. Historiographically speaking.
research-intensiveness of U.S. companies—and certainly of the U.S. government—paled in comparison to the pharmaceutical complexes of Europe, particularly firms like France’s Rhône-Poulenc, Britain’s Burroughs-Wellcome, and the powerful cluster of German and Swiss commercial laboratories like Bayer and Hoffmann-LaRoche. But the policies of the wartime American state in subsidizing development, providing unrestricted information from the British exchange, and creating a forum for industrial-academic collaboration, represented the most important catalyst for the rise of Big Pharma in the U.S.\(^\text{54}\) This foundation not only gave economic muscle to one of the boom industries of the twentieth century—directly propelling firms like Merck, Glaxo, and Pfizer to global status—but also helped to undergird the justifications and ideologies behind America’s aid programs to developing countries during the Cold War, by projecting the U.S. as a biomedical power.\(^\text{55}\) In short, the exchange of penicillin had not just a scientific impact, but a geopolitical one in the coming decades.

For its part, Britain would never return to the prewar parity with the U.S. it enjoyed in pharmaceuticals.

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\(^\text{54}\) Ibid., 38-61.

Pentagon says you can’t

The transatlantic imbalance in reaping the fruits of joint penicillin development represents a standout case, but it was not the only one. In jet engines, atomic bombs, and other technologies, we see a similar pattern emerge: Key developments of the war and immediate postwar saw important initial data moved from overseas to U.S. firms through state channels; the resulting technologies were developed or honed in the U.S.; and then they were blanketed in security restrictions to prevent foreign disclosure, even to allies. After the war, this walling-off would translate directly into transatlantic commercial rivalries and military-scientific arms races.

It happened with atomic bombs, a subject exhaustively documented by scholars. Despite the critical boost given to the U.S. nuclear program by visitors like Marcus Oliphant, by 1943 the U.S. had placed a blanket of security restrictions on most aspects of the Manhattan Project, shutting out all foreign governments, including those of Britain and Canada. British scientists and leaders lodged forceful protests and got the exchange reopened, but security paranoia surrounding atomic weaponry remained on the increase in Washington. American mistrust was ultimately consummated by the Atomic Energy Act of 1946, which, by making U.S. nuclear weaponry an internal state secret, dealt the final blow to lingering hopes of transatlantic cooperation. The Clement Atlee government was incensed by this perceived betrayal; as Foreign Minister Ernest Bevin fulminated, “We’ve got to have this thing over here whatever it costs. . . We’ve got to have the bloody Union Jack on top of it!” Nationalist pride and perceived strategic necessity led Britain to inaugurate its own atomic program,
ultimately testing a successful bomb in 1952, seven years behind its ally. Not until 1958 did the two countries resume nuclear cooperation.56

It happened with jet engines. British engineer Frank Whittle first successfully demonstrated a jet engine in 1937, and by 1941 a jet-powered aircraft was being test flown. But while the Tizard Mission had brought some cursory information about British jet developments to the U.S., it was not made a central focus of the exchange. In May 1941 the Royal Aircraft Establishment requested that the U.S. send two delegates to learn of Britain’s progress in jets. American officials quickly realized that Whittle’s team was leaps and bounds ahead of the project being conducted by NACA in the United States. As Vannevar Bush put it, the British jet was “extraordinarily advanced and no time should be lost on the matter.” Plans for production in the U.S. commenced immediately.57

Not all Americans were convinced that jets represented the future, however. Even after seeing the revolutionary British design, Army Air Force general Hap Arnold said that “In my 30 years in aviation I have seen too many of these things come up that are going to completely revolutionize everything and do away with all heretofore existing forms of aircraft, so while I am enthusiastic, I am not super-enthusiastic.” Testing went forward by NACA and American firms, but the Americans lacked the key British innovation of a centrifugal compressor, and the engines produced in the U.S.

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remained substandard. As a result, American programs were either disbanded or began incorporating British research into their designs. Notably, the only U.S. design submitted by existing steam turbine manufacturers to be flight tested during the war, the Westinghouse 19B, incorporated British combustor technology. The company nevertheless called the engine “the Yankee” because of its supposedly American origin. The Navy, meanwhile, dropped its own engine altogether once it received a license to build a de Havilland Goblin jet from Britain.\(^{58}\)

Jets would become a key site of international technological competition in the coming years, with faster, higher, and more powerful aircraft enabling new modes of transport, reconnaissance, and weapons delivery. And while it would be fruitless to speculate where the American jet program would have been without the boost of British knowledge, it is clear that Britain provided both a shot in the arm during the war, and a key source of competition stimulus after peace came. Ultimately, the U.S. aviation industry became the unquestioned global leader by the 1950s.

The matter of supersonic aerodynamics is more complex, and illuminates something about the Anglo-American exchange distinct from mere U.S. self-interest.

Principals involved in the supersonic flight development program in Britain—including test pilot Eric “Winkle” Brown and chief aerodynamicist Dennis Bancroft—insisted for decades that the race to break the sound barrier followed a similar imbalanced exchange pattern to that we have seen in the case of penicillin. Both British and American teams were stuck at a fundamental obstacle in

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\(^{58}\) Ibid. I have triangulated the identity of the Goblin engine from the mention of “Halford-Havilland” by Dawson and a review of the production chronology of de Havilland designs.
trying to reach supersonic speeds: the design of the aircraft’s tailplane, which in its then-current form was causing loss of control and breakup as the aircraft approached the speed of sound, killing several test pilots. In an effort to solve these problems, American officials worked out an arrangement with British manufacturer Miles Aircraft Limited and the Royal Aeronautical Establishment whereby supersonic research would be exchanged reciprocally with U.S. developers. In the version given by the team from Miles, the British government instructed them to hand over all information on their developments to the Americans—particularly a new, all-moving tailplane that ensured stability through transonic speeds—but when it came time for the U.S. to reciprocate, in the words of Bancroft, “When we were trying to arrange the visit, they just said, ‘Sorry. Secrecy. The Pentagon says you can’t.’”59 Brown—perhaps Britain’s most renowned test pilot—doubted that the U.S. designers had much reciprocal information to give, and noted in any case that “Certainly the Americans were the beneficiaries from all this, as our fifteen-month lead over the Bell X-1 supersonic contender disappeared.”60 Chuck Yeager’s X-1 broke the sound barrier using the all-moving design on October 14, 1947, forever marking the achievement of supersonic flight as an American one.

The claim of U.S. duplicity in breaking the sound barrier has spawned a cottage industry of unscholarly claims, counterclaims, and conspiracy theories. There is ample reason to suppose that the variable-incidence tailplane was arrived at independently by both countries; there is also the testimony of the British designers and the broader context of the imbalanced exchange pattern to

suggest otherwise. The truth is likely impossible to determine. What this episode does illuminate, however, is a growing distrust between transatlantic allies by the latter stages of the war. Questions like who invented radar, who broke the sound barrier, who was the world leader in jet engine design, and who had invented penicillin began to sow discord in the dawning age of high-technological nationalism. Technological primacy was now becoming a diplomatic matter. This was doubly true for Britain, whose place in the future world order seemed less assured than that of the U.S. In the case of supersonic flight, for example, British director David Lean’s triumphalist 1952 film, *The Sound Barrier*, told a breathless tale of the tragedy, toil, and ultimate victory of the supersonic test pilots. The film had a twist, though: In Lean’s telling, it was the British pilots who achieved the feat, allowing the nation to project and celebrate technology as a measure of British geopolitical power at midcentury. As a Parisian journalist noted at the time, “In the hearts of our neighbors, the battle of the sound barrier is a continuation of the Battle of Britain.”

With peace just around the corner, new questions of secrecy, primacy, intellectual property, industrial competitiveness, and global leadership in high-tech sectors like pharmaceuticals and aviation, began to circulate across the ocean along with the exchange reports. New suspicions and new resentments began to roil as the postwar order came into focus, and as U.S. industry began to outshine its British counterparts. To these suspicions we now turn.

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Giver’s remorse

As the war drew to a close and a return to peacetime economic competition became imminent, British officials began reconsidering the enormous technical exchange with America to which they were bound. As Sir Charles Fairey, director-general of the British Air Commission, wrote to Whitehall in early 1944, the war had taken a heavy toll—the British standard of living was at a low ebb, the bulk of its overseas exports markets had been lost, and soon Lend-Lease would be gone and Britain would be “left to our own resources.” Why then, he wondered, did the UK continue to “give lavishly of all we had of scientific discovery and development?” Others agreed. The Admiralty’s R&D office stressed in a policy statement that commercial strength “depends very much on monopoly in technical information,” and that the continued free distribution of such information abroad was “to a great extent at the expense of post-war industry” and should be reconsidered. Britain, it seemed, was now looking for an exit strategy from the open policy it had upheld since Tizard departed in 1940.

Beyond mere postwar considerations, however, officials also began to soberly assess the damage an imbalanced system of knowledge transfer with the United States had wrought upon British industry. As in the case of penicillin, American firms had paid no heed to the needs of their overseas competitors, and American policymakers proved to be of scant help in safeguarding their

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63 Letter, C. Fairey, British Air Commission, Washington, D.C., to Sir Stafford Cripps, Ministry of Aircraft Production, March 16, 1944, BT 305/3, UKNA.
64 Assistant Controller (R&D), Royal Navy, "Exchange of Technical Information with U.S.A., Proposed Statement of Position and Admiralty Policy," September 20, 1944, BT 305/3, UKNA.
ally’s rights. It was thus, by the latter stages of the war, left to British diplomats to fight—ultimately in vain—for the defense of their industries’ commercial interests.

The inability of the U.S. government to provide reciprocal guarantees on the transfer of secrets—for both bureaucratic and political reasons—had worked significantly against British interests. As we have seen, from early in the exchange the UK government provided indemnity to the U.S. government against any and all patent claims by British nationals, but U.S. negotiators could not and would not do the same. One prominent justification given for this was that American obligations under Lend-Lease were so vast in relation to those of the UK that British officials had no place in taking exception to small, unavoidable areas of non-reciprocity like patent indemnity. Indeed, the Roosevelt administration already hoped to maximize America’s exploitation of Reverse Lend-Lease in order to quell domestic political sentiment against the program; the poor propaganda value of granting blanket indemnities to foreign governments and firms made such cooperation a non-starter.

But such cynicism about the imbalance of goods sent between Allies was based on a false equation of Lend-Lease’s raw war materiel with the kind of intellectual property transfer the British had initiated under Tizard. In fact, from a scientific standpoint the balance between the two allies tilted firmly in the opposite direction. According to OSRD data through January 1945, the number of scientific and technical reports the United States had sent to Britain and the Dominions stood at 15,630, while Britain and the Dominions had sent more than double that number—35,500—to the

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65 Memorandum, Capt. L.J. Douglas-Mann for Director-General, B.A.C., “In regard to negotiations between the U.K. and U.S. Governments…,” April 26, 1942, AVIA 10/129, UKNA.
Moreover, only in the latter half of 1944 was it observed that the balance of scientific information had reached equilibrium and possibly begun to flow back eastwards across the Atlantic, as the American science establishment’s absorption of British knowledge had begun to bear fruit.  

But it was not volume of information alone that put Britain at a disadvantage in the exchange. Most critically, American administrators had shown a consistent neglect of British interests in their transferal of secrets to American industry without proper safeguards, resulting in an enormous loss of British commercial intellectual property to U.S. firms.  

As Fairey noted, since the time of the Tizard Mission the transatlantic exchange had been premised on the belief that “neither government should desire to profit—nor to allow its nationals to profit—by reason of free releases for war purposes,” and that each side would “take all practicable steps to confine to war purposes the use of unpatented devices, designs, and processes having commercial as well as military value.” British officials had no choice but to trust in the good faith of this informal agreement, and in any case, the desperation that marked the early days of the exchange meant that most of Britain’s cutting-edge technologies were transferred before patents could be filed even in the UK, let alone in the United States. Moreover, British civil servants simply lacked the

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66 Outgoing number derived from 16,380 reported sent, minus 750 medical reports sent to Russia. It should also be noted that, for obvious reasons, the value of information exchanged cannot be entirely ascertained from number of reports alone, particularly as the volumes of information contained therein varied wildly from case to case. But the enormity of the imbalance between British and American reports sent—227%—clearly indicate the general trend of knowledge transfer. Report, Eugene W. Scott, Assistant Liaison Officer, to Homer Jones, Foreign Economic Administration, March 15, 1945, RG227: OSRD, Records of the Liaison Office, Entry 169 (NC-138), Box 41, NARA.  
68 Letter, C. Fairey, British Air Commission, Washington, D.C., to Sir Stafford Cripps, Ministry of Aircraft Production, March 16, 1944, BT 305/3, UKNA.
resources to keep adequate track of what was being given away, and so largely entrusted secrecy and intellectual property matters to U.S. government officials on the receiving end.

American liaison officers, however, did not make primacy of discovery a priority when it came to distribution of research to private industry. As the British discovered, the U.S. government, despite having agreed to “require release conditions as far as practicable,” was able later simply to say that “in many cases they were not practicable,” and that was that. When the British Board of Trade did eventually launch an effort to ascertain what had been given away without conditions to U.S. firms, the American reply was that no one in London or Washington knew, and that, with “some 100,000 items of information” piled up by then, no one was going to be able to find out.69

What officials did soon find out, however, was that while British departments were “too busy carrying on the war” to pursue patents, “the Americans were under no such disability.” By 1944 patent applications were beginning to appear in the UK from American firms, claiming early dates of U.S. invention for knowledge that had in fact been sent from British scientists. Due to the volume of exchange and the difficulty of red tape, however, it was nearly impossible to prove that a given innovation had been communicated to the U.S. from Britain. Worse, under British patent law such proof would still provide no basis for action against the application, even “in fraud of the British true and first inventor.”70 The writing seemed to be on the wall for the UK’s advanced industries.

69 Letter, W. Palmer to L. N. Palmer, Esq., Treasury, November 14, 1944, BT 305/3, UKNA.
70 “Notes, with a suggested amendment of the Patents Act...,” Research Department, Admiralty, November 9, 1944, BT 305/3, UKNA.
Whitehall scrambled to enact a response. In March 1944, Minister of Aircraft Production Sir Stafford Cripps tasked Sir William Palmer to chair an Interdepartmental Committee on Safeguarding Post-war Patent Rights in Inventions under the auspices of the Board of Trade. Its first task was to investigate patents in the radio industry, which were found to be in such a “sorry state of affairs” that the committee’s remit was expanded to investigate all technical fields.71

While the committee proceeded with its inquiries, British officials grasped at any other levers of diplomatic influence remaining to prevent massive loss to their national industries. Such efforts, however, were too little, too late. The Board of Trade considered “bringing some pressure on the U.S.” by refusing to send further information to American firms that wouldn’t consent to enter postwar usage agreements, but this was a hollow threat. American conglomerates well knew the British need for continued large-scale production, even this late in the war. In May 1943 General Electric simply refused to accept any information from Britain with release conditions attached. The British Air Commission, among others, responded with indignation at being “gang[ed]-up on” by large firms, but realized the only choice available to them was either to drop all conditions, or to hold up essential production—and delays or reductions in materiel would realistically be unallowable.72

71 The committee recommended emergency measures such as diverting civil servants skilled in patent rights issues to help sort the mess out, but the problems proved so intractable that it wasn’t until February 1953 that a workable Anglo-American agreement on patents and technical interchange for defense purposes (Treaty Series No 9, Cmd 8757) was signed. Letter, D.H. Johnson to Sir William Palmer, April 20, 1944; and Draft Interim Report, Interdepartmental Committee on Safeguarding Post-War Rights in Inventions, 1944., BT 305/3, UKNA.

American industry, in short, held all the cards, and U.S. government and military personnel were of little help. Representatives from the U.S. Army and Navy had already confirmed to the Joint Patents Committee that protection issues from earlier in the war would be “impossible for them to go back and correct.” Thus, by March 1944, the British Air Commission and others began to concede that UK inventors seeking postwar protection would have no choice but to rely on any patents they might manage to obtain in the U.S. from that point forward.

Given these bleak prospects, British officials had little recourse but to regroup and look for other ways to restore Britain’s technological advantage in the postwar world. This led to a scramble of committees, debates, and investigations in London analyzing how Britain could regain parity with the United States. Sir Stafford Cripps convened a new committee to consider ways to improve military aircraft research, zeroing in on poor pay for scientists in the Ministry of Aircraft Production. In Parliament, meanwhile, members agreed that British scientists were underpaid. A debate in the

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73 Letter, L.J. Douglas-Mann, British Air Commission to P.H. Goffey, Esq., Ministry of Aircraft Production, June 24, 1943, AVIA 10/129, UKNA.
74 Letter, C. Fairey, British Air Commission, Washington, D.C., to Sir Stafford Cripps, Ministry of Aircraft Production, March 16, 1944, BT 305/3, UKNA.
75 The ministry’s Director of Research, Ben Lockspeiser, received a salary of only £2000, and himself thought eminent scientists should earn at least that much. Rear Admiral J.A. Furer (?), “Memorandum for Post-War Research File,” 19 August, 1944. Office of Naval Research papers, RG298, Stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), Box 52, NARA. A similar organization was the Brabazon Committee, which began meeting in early 1943 on the subject of postwar commercial aviation. It was realized in London that the division of manufacturing in warplanes agreed upon with the U.S. would leave Britain without any expertise, experience, or facilities for the production of large transport aircraft after the war. This would clearly jeopardize the British aviation industry. The Brabazon Committee thus came up with a series of theorized designs for postwar airliners, which the Ministry of Supply took to the research phase. Several of the Brabazon designs proceeded to manufacture in some form, serving as key cornerstones of the British aviation industry, although most were commercial failures—by the 1960s, the U.S. had clearly monopolized the global airliner market. See also Engel, *Cold War at 30,000 Feet*; and Keith Hayward, *Government and British Civil Aerospace: A Case Study in Postwar Technology Policy* (Manchester: Manchester University Press, 1983).
House of Commons in April 1944 led to general consensus that scientific compensation, education, and bureaucracy all needed improving. Universities would need expansion to the tune of £10 million over five years, and emphasis would need to be placed on both cultivating new students and channeling demobbed soldiers into new technical fields. Ultimately, in August 1944 the Government issued a White Paper detailing existing state-science mechanisms, making clear that improving Britain’s science and technology output was to be a key economic priority after the war.

The real takeaway in Westminster from the exchange experience, however, was that American industry—intentionally or not—was crowding Britain out of global competitiveness. In the same 1944 Commons debate, soon-to-be prime minister Clement Atlee argued that the British government had long been alert to the value of technoscience—it had won the war, after all—but the “winning of the peace” was going to require an end to the sluggishness of private UK industry in adopting and applying the latest technological advancements. His words were bolstered by a report by industrialist Sir Harold Hartley, circulated at top levels on both sides of the Atlantic, noting that the only hope for Britain’s postwar economy was to increase the value—rather than volume—of its exports by wielding Britain’s “inventiveness and technical skill.” U.S. industry, Hartley noted, not only appreciated science more than that of Britain, but propagated it, recognizing its “definite sales appeal.” It was thus “impossible to avoid the conclusion” that Britain’s position in the world was

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78 Howard Bucknell, Jr., Charge d’Affairs ad interim, to Secretary of State, Washington, “Transmitting Text of Debate in the House of Commons,” May 16, 1944 RG227, OSRD, Records of the Liaison Office, Entry 169 (NC-138), Box 24, NARA.
now going to hinge almost entirely on the extent to which it could regain its industrial scientific
strength vis-à-vis other global powers like the United States.\(^79\)

The great patriotic techno-war

The Hartley report proved especially prescient in its remarks about the propaganda value
American industry gave to science and technology, particularly as the war drew to a close. Just as
Britain took stock of the past and turned toward its postwar interests, so too did American private
industry, which jockeyed for both material and political postwar advantage through rhetoric, public
relations campaigns, and lobbying. Firms sought a ‘return to normalcy’ in which the stunning new
technologies of the war could be marketed privately, with minimal involvement from the newly-
expanded American government that had played such an enormous role in their development. To
achieve this, corporations looked to exhibit both patriotism and technological sublimity to mass
audiences. Ultimately, by framing the astonishing inventions emerging from the war as largely
products of American free enterprise, they also helped to indigenize them, thereby obscuring the
foreign origins of the new cache of world-changing technologies. This strategy provided one essential
pillar of postwar U.S. technological nationalism. (We will explore others in the following chapters).

In 1944, science writers Norman Carlisle and Frank Latham summed up the attitudes and
outlooks of industrialists, commercial scientists, engineers, and publicists in a book called Miracles
Ahead!, a comprehensive popular-scientific compendium aimed at describing the way rising

Little, Inc., Cambridge, Mass.), 1944. Records of the Office of Naval Research, RG298, stack 370, Coordinator of
Research and Development, General Correspondence 1941-46 (Entry UD-1), Box 52, NARA.
technologies, many of which were spurred by the war, would affect ordinary lives in the postwar world. Carlisle and Latham breathlessly endorsed the opinion of a business leader who noted that, “Now that industry has embraced science … the most extravagant prophecy will fall short of potential accomplishment!”

Miracles Ahead! was not unique. Rather, it echoed what became a voluminous wartime outpouring of industrial self-promotion in magazines, pamphlets, articles, and advertisements. These trumpeted the ways industry had wielded science to win the war, and how it now promised to wield it for consumer abundance. Wartime advances in metallurgy would mean lightweight helicopters for urban transport. Penicillin and other war-derived antimicrobials like streptotricin and gramicidin would lead a new plethora of “germ-killers” to be administered for everyday illnesses. The electrical science behind radio and other innovations would soon become electronic “watchmen” guarding against everything from home invasion to infant diseases to unripe melons. Robots would release workers from the monotony of labor and free housewives from the drudgery of housework. And private commercial facilities like the new RCA Radio-Electronic Laboratories in Princeton, although still developing the “secret weapons of today,” would soon be “where new electronic wonders will become handmaidens of tomorrow’s miracle world.”

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A common refrain in these proclamations was that firms had selflessly answered Uncle Sam’s call to perform their patriotic duty. The war, they argued, had actually constrained American business, but now it was ready to return to serving the consumer. As a representative of the Manufacturing Chemists’ Association told a postwar Congressional committee in 1948, “In wartime, or under the threat of war, industry is as much a branch of the Armed Forces as the Army, the Navy, the Air Force, or the Marine Corps. Our aim and goal is the same.” 82 The DuPont Company lamented to its shareholders that the applied science needs of the war had meant a hiatus for its extensive program of fundamental research, but boasted that in this scientific war, “the American chemical industry was called on to take a leading part,” not only in achieving victory but in husbanding the national economy. DuPont had played its critical role in attaining victory and peace, and now it was ready to return to normalcy. 83

Beyond mere commercial motivations, industry had other incentives to trumpet its role in crafting the forthcoming civilian utopia. One was to avoid the public relations disaster that had followed the previous war, in which citizens and politicians alike had decried war profiteering by large corporate “merchants of death.” 84 Firms like DuPont trod a fine line between disassociating

82 Transcript of statement, Norman Arthur Shepard (on behalf of the Manufacturing Chemists’ Association of the United States) to the House Armed Services Committee, April 16, 1948, box 103, Vannevar Bush papers, LoC.
83 W.S. Carpenter, Jr., Statement to the Stockholders of E.I. de Pont de Nemours & Company, Wilmington, Delaware, March 7, 1946, Hathi Trust Digital Library. https://babel.hathitrust.org/cgi/pt?id=mdp.39015049249157;view=1up;seq=1
themselves from the business of killing while still proclaiming their centrality to winning the war, all while emphasizing that their scientific output would spawn a new postwar material paradise.

Another incentive was to head off what conservative business interests viewed as alarming momentum towards government involvement in science and industry after the war. The industrial strategy of framing the war’s dramatic new technological advancements as products of old-fashioned American commercial dynamism provided a potentially useful counterargument against already-emerging proposals for a National Science Foundation. F. C. Jones, president of a New Jersey electrical cable company, wrote to Congress that “no great scientific discovery or invention was ever made, or ever will be made, by a governmental bureau.” L.K. Sillcox, an official from the New York Air Brake Company, told an engineering conference at Purdue University that government involvement with advanced industry meant that the “spirit of pioneering is becoming extinct,” and the U.S. “may lose its leadership in scientific research.” The editorial board of the Chicago Tribune reflected all of them when it argued that the American state had had to call on the ingenuity of industry to solve the scientific puzzles of the war, for the “knowledge and the skills were not to be found in government.” Industry had perfected the atomic bomb, it argued, in spite of the fact that “the army and government were constantly in the way,” imposing needless security restrictions and red tape. And had not RCA invented sonar and infrared “eyes?” (In fact it had not—sonar in particular was an Anglo-American armed forces innovation which had arrived in its modern form

85 Letter, F.C. Jones to Senator H.M. Kilgore, May 3, 1943, RG298: Records of the Office of Naval Research, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
86 Presentation, L.K. Sillcox, “Engineering Evolution from War to a Peacetime World,” Purdue University, Lafayette, Ind., December 5, 1945, p. 20, Vannevar Bush papers, box 103, LoC.
with the Tizard Mission). Freedom of enterprise, concluded the *Tribune*, had won a perilous war and was about to “open up new frontiers” in peacetime—and “government will have contributed nothing to that result.”

The shifting terms of debate on the U.S. government’s place in winning the glorious technoscientific war nevertheless signaled that Americans had already come to internalize a new commonplace about their national capacity for achievement. Sublime American innovations had won the war—all parties agreed on that much. Their differences now hinged on domestic science policy going forward. While a cadre of New Dealers and moderate science administrators now sought a way to maintain the OSRD arrangement in peacetime, industry claimed that preexisting arrangements and the inherent American values of competition, incentive, and ingenuity had brought victory. In either case, the efficacy of American science and technology was taken as given, bolstered only further by the stunning technological victory of the war. The unintended, but powerful, effect was to obscure the British origins of many of the innovations and bureaucratic arrangements, as well as the relative prewar laggardness of the American state-industrial nexus.

In fact, U.S. views on Britain generally began to shift from being the “goldmine” of the Tizard era to a limping “sick man” in industry and productivity. American economists and think tanks increasingly framed a British economy and standard of living devastated by war as in fact being a product of inherent systemic inferiorities in the UK’s political and industrial system. In 1943 Ted Wright, vice-president of the Curtiss-Wright Aeronautical Group, told BBC listeners that despite

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years’ worth of a head-start in large-scale research, design, and tooling, Britain’s aviation factories now spent double the man-hours per pound of aircraft than American ones, which indicated a profound lack of modernization in manufacturing technology compared to the United States. Britain’s stagnation, argued observers like Wright, predated the war and had as much to do with mismanagement, inefficiency, cartelization, and failure to keep up with modernity in manufacturing as it did the ravages of combat. Britain was undercapitalized and not set up for the relentless revolution of innovation, while American firms had so naturally “startled the world” with their buildup.\(^8\) It was becoming increasingly difficult to conceive of this ailing ally as having acted as a scientific Prometheus for the United States’ war machine just a few years earlier.

Moreover, as the U.S. turned its attention to how it was going to settle the staggeringly complex mountain of mutual debts and obligations that had been accrued in the war, scientific matters largely faded from view. A 1944 amendment to the Lend-Lease Act gave the President wide latitude to determine or nullify repayment demands, but public debate on the issue largely centered on reducing or eliminating allies’ obligations based on “equality of sacrifice” in lives lost and national resources committed, rather than knowledge transferred or technical aid received. When a U.S. Army information booklet for G.I.s delved into the complexities of Reverse Lend-Lease, it focused on how

\(^8\) Lewis C. Ord, *Secrets of Industry* (New York: Emerson Books, 1945), p. 239, 250. For another example, see “Wealth of (Two) Nations: A Comparison of British and American Industrial Productivity,” (Economic Survey Series no. 409, 1947) by the conservative American Enterprise Association (now Institute), which compiled a series of reports from *The Economist* to suggest that Britain would need to double its average industrial efficiency in a single generation in order to retain its “old position” in the competitive postwar world. This would have to come, they said, not just through managerial changes and workplace streamlining but also through better commitment to technological advance. The compiled reports argued that British industry too often ignored crucial technological innovations (e.g. synthetic rubber), while government patent and tax structures actually disincentivized commercial research. Digitized by Hathi Trust, [https://babel.hathitrust.org/cgi/pt?id=coo.31924013846146;view=1up;seq=22](https://babel.hathitrust.org/cgi/pt?id=coo.31924013846146;view=1up;seq=22).
Britain had provided quartering, medical aid, imperial raw materials, facilities, and food (“Almost all the bread eaten by our troops while training in Britain was baked with flour furnished under Reverse Lend-Lease”). Nowhere did it mention scientific exchange.89

The British, of course, were well aware of what they had given. One official, Leslie Chance of the British Supply Council, doggedly endeavored to tally the scope and value of what had been transferred to America. As we have seen, this was an impossible task—the unrestricted nature of the exchange and the removal of quid pro quo provisions in the early days of the Tizard Mission rendered valuation not only unfeasible but undesirable for the duration of the war. Chance continued his pursuit at least into 1942, despite being warned off by the Admiralty, Air Ministry and others.90

Even at this early stage in the war, Chance calculated—perhaps excessively but in all earnestness—that the value of scientific information and technological knowledge given to the U.S. was “many times greater” than what had been received to date under Lend-Lease. He quoted the Royal Navy’s Rear Admiral J.W.S. Dorling in estimating that the value to the U.S. of Asdic (sonar) alone was likely worth “half the replacement value of the entire U.S. fleet.” But Chance recognized that it would be poor public relations for Britain to propagandize this belief to the U.S. public, and instead wrote that

89 Taylor, “How Shall Lend-Lease Accounts Be Settled?”
“there is only one way for such a story to be told, I suggest, and that is for the Americans themselves to tell it.”

As we have seen, however, by war’s end most Americans had come to believe that there was no story to tell at all.

A new frontier

Despite industry’s attempt to wrestle public narratives toward a laissez-faire focus on its own achievements, by war’s end the nature of American state science had nevertheless changed too much for a return to normalcy. New relationships between government, academia, the military, and the private sector—as well as a new awareness in Congress and in the White House of the power of R&D—precluded a regression to the prewar order. Moreover, the lionization (and self-promotion) of organizations like the OSRD and personalities like Vannevar Bush—the empire-builder who once rose out of his sickbed, met with Congress, and “walked away with $135,000,000,” according to one telling—provided powerful archetypes for the political legitimation of a government-led nexus for science and technology. Legislation for a National Science Foundation was already under debate in the Senate, and reports by Bush (the famous Science: The Endless Frontier) and White House aide John Steelman on government research circulated rapidly throughout the highest corridors of power. Simply put, the American state’s relationship with technoscience had changed.

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91 Memorandum, L.G. Chance to R.H. Brand, Esq., July 24, 1942, AVIA 30/1010, UKNA.
92 S.J. Woolf, “Chief of Staff on the Science Front: Dr. Bush Directs a Research Staff that Spends Almost $3,000,000 a Week to Develop War Weapons,” New York Times, January 23, 1944.
Of course, triumphal wartime narratives of “scientists against time” did little justice to the fact that the time constraints against which they were fighting had largely been self-imposed, a product of sluggish engagement by the American state with R&D in the years before the war. That, more than the accomplishments of enemy states, was what yielded a research bureaucracy ill-prepared for the challenges it had to face after Pearl Harbor. Nevertheless, despite the dramatic way in which these prewar shortcomings were overcome, the construction of peacetime state-science in the U.S. was still to prove enormously challenging for the new members of the Tizard Generation. The next chapter will discuss the impact of those challenges on the trajectory of both American bureaucracy and technological nationalism in the early Cold War.

The jet engine, supersonic flight, radar, sonar, the atomic bomb, antibiotics, microwave generators, DDT—it is a list that reads like a who’s-who of sublime prestige technologies central to America’s self-definition in the Cold War. And indeed, during the coming decades, the U.S. would use those crucial technologies as a foundational cache onto which other stunning achievements—spacecraft, intercontinental missiles, the internet, GPS navigation, the microchip—would be grafted by state activity. American projection of those national achievements to the world would inextricably bind the concept of global power with that of technological might for the remainder of the twentieth century.

But that conception centered on the acceleration in state R&D provided by the original list. And key secrets, knowledge, research, memoranda, and prototypes of the innovations on that list
arrived on American shores in 1940, in Bowen’s box, and in Tizard’s crates and pallets. The Anglo-American science exchange of the Second World War represented a key moment in which important material underpinnings of the American techno-nationalist ideology arrived wholesale from a desperate foreign state. And in aiding the creation of a civilian bureaucracy to assimilate and further develop those key technologies, the exchange also set off a snowballing bureaucratic conjunction of academia, government, and industry. As we will see, the ways in which Americans adopted and adapted the technologies and institutions of the exchange after the war would transform that organizational and ideological confluence into the phenomenon we commonly call the military-industrial complex.

It is also important to take a moment to underscore that Britain was no mere victim of American technological thievery, but rather a global power whose self-conception as a power derived in part from its technological strength, and who chose to use that strength as a diplomatic enticement to tempt alliance from the United States. It succeeded. Thus, despite having largely eschewed the sizeable research bureaucracies of Europe before the war, the U.S. state nevertheless became engaged in the international conception of technology as geopolitical power. The war proved the efficacy of that formulation, and the Cold War consummated it as central to global politics—eventually. The following chapters will show the tortuous path that technological hegemony took to achieve diplomatic and doctrinal primacy in the United States.

Of course, there was nothing inevitable about the ways in which the U.S. absorbed, assimilated, and developed British technologies and bureaucratic templates after the war. The
exchange thus helps us to better understand the mobilization of the war economy and the success of war production in the U.S., by showing an important alternative lever that the U.S. state used—beyond investment, regulating supply chains, and bolstering productive capacity—to strengthen U.S. national and commercial interests. U.S. corporations were gifted the foundation of a scientific frontier, and onto it they added improvements, ramped up production and output, and indigenized the results as American industrial wartime accomplishments. Although many of the scientific and technological principles of that accomplishment originated overseas, the enormous U.S. applied research and production machine that grew out of the war furnished American industry with all it needed both to profit from the advancements and to proclaim them as its own. This served a nationalist purpose, and industry was happy to oblige—as long as its interests were served.

Indeed, the big business of science and technology became blatantly clear as British officials and American industrialists eyed the coming peace. Their scramble to protect commercial rights over state-derived knowledge foreshadowed many of the industrial incentive paradigms and globalized technological impulses that would undergird Cold War research and development programs. The grey area between national security and commercial secrecy was rendered ever more blurry in the coming decades.

Thus, while the souring of the British exchange does much to demonstrate the wartime persistence of private self-interest over public controls, it also allows us to better historicize the growing rhetoric and ideology of national security vis-à-vis technology. One of the main changes of the war was the forging of a new awareness among military, national security, and administration
officials as to the power of scientific research and the nation’s command of high technologies. By the same token, as the U.S. government consolidated its national security apparatus during and after the war—and as the global outlook darkened—state actors began more aggressively, intentionally, and actively to seek advantages—be they strategic, technological, or commercial—using the increasingly pertinent veil of secrecy and security as a justification. Transnational flows of R&D, in other words, becoming an increasingly central concern of military and administration planners.

The line, however, between essential national security information and technology-based commercial interests—the latter of which remained just as central to U.S. global power as an increasingly sophisticated weapons stockpile during the Cold War—remained blurry. State actors’ increasing use of secrecy and national security discourses as they took steps to ensure the undisputed U.S. command of technologies with complex international roots helped to crystallize the self-reinforcing military-industrial complex as the Cold War went on. In short, the Second World War in the U.S. saw both an increase in secrecy surrounding new weapons, and a weaponization of secrecy in commanding them.

In the next chapter, we will explore how an American state at odds with itself, torn between anachronistic domestic politics and the futuristic technoscientific ideology of the Tizard Generation, wrestled to maintain the war’s scientific and institutional changes in the postwar world.
Chapter 3: The Aimless Frontier

One of the best-known moments of the presidency of Dwight Eisenhower was also his final bow, a televised farewell address delivered to the nation on January 17, 1960. In it, the outgoing leader famously warned Americans to guard against what he coined a historically unprecedented “military-industrial complex,” a dark force that had been swept into power by a “technological revolution during recent decades.” Research itself had been revolutionized, he noted, and “partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity… The prospect of domination of the nation’s scholars by Federal employment, project allocations, and the power of money is ever present—and is gravely to be regarded.”

Eisenhower was not alone, nor was he the first to worry about a takeover of the government by martial and technological interests. Eight years previously, a similarly solemn warning was issued by Albert Einstein, forcefully censuring the security paranoia then casting a pall over American research and development. The nation’s true ailment, wrote Einstein, “seems to me to lie in the attitude which was created by the World War and which dominates all our actions; namely, the belief that we must in peacetime so organize our whole life and work that in the event of war we would be

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sure of victory.” This attitude, felt the eminent physicist, explained all of the ills of Cold War life, and would, “if it does not rectify itself, lead to war and to very far-reaching destruction.”

Many political thinkers and scholars alike have also hewed to these assumptions in the decades since. The National Academy of Sciences’ official history, for example, argues that, as a result of the war, “clearly, the federal government would continue to support large-scale programs of research in the universities, private institutions, and industry, both for future national defense and for the nation’s general welfare, and needed only a mechanism through which it might continue to draw on the vast research capacity of the nation in peacetime.” In a now-infamous historiographical debate between Paul Forman and Daniel Kevles on the national security co-optation of American physics, Forman posited that “as everywhere, the man who pays the piper calls the tune.”

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4 Cochrane, National Academy of Sciences, Chapter 14.
Kevles disagreed, he and Forman nevertheless shared a conviction that there had been a “radical change in attitude toward science, toward national security, and toward the relationship between them on the part of both the military and the civilian leadership of the United States.”

By the mid-1950s the American state had indeed grown to a size and power unprecedented in the nation’s history, and had done so arm-in-arm with enormous, publicly-backed industrial technology producers. Wealth and resources had concentrated in snowballing and secretive ways that seemed to undermine existing legal checks, and the whole process seemed fed by an obsession with security and war. As Eisenhower prudently warned, these developments were both “new in the American experience” and a threat to democracy itself—for “in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite.”

But was the nation in the thrall of a scientific and technological elite throughout this period? Certainly, as we have seen, the Second World War represented a crucial pivot toward state science and technology for the United States, not only in bureaucratic terms but also in the implantation of a belief that research and development had become a crucial factor in the nation’s global strength. The dark clouds hovering over the nation described by Eisenhower and Einstein, then, would seem to

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7 Eisenhower, “Farewell Address.”
suggest that an ideology of technoscience-as-security had indelibly risen to axiomatic status in the halls of power after 1945, both inside Washington and out. There would seem to be a dangerous consensus of a technological-industrial nature, yoking the existential security of the United States to its ability to continually stoke the furnace of a bellicose, monolithic R&D machine.

However, if we peel back the layers of the implementation of the technoscientific security ideology in the U.S. state in the first decade after the Second World War, we see a much more complicated, haphazard, contingent, and—in a word—messy story than any near-omnipotent Power Elite would ever have tolerated. In this chapter, I wish to demonstrate that the need for expanded state support in science and technology, and, to a lesser extent, the importance of technoscience itself to the power and strength of the nation, was by no means a consensus or anything approaching it in the nearly two decades after the outbreak of the Second World War. Indeed, powerful interests frequently mobilized political and bureaucratic resources to oppose expansion of the state in the realm of science and technology, and to deny to scientists the kinds of enormous resources they had begun to enjoy and demand with the wartime expansion of the government.

My aim is not to challenge the decades of voluminous scholarship on state intrusion into the laboratory begun by Forman and Kevles, nor to argue that there was not a military-scientific reorientation as a result of the war. Rather, the purpose of this chapter is to contextualize these changes in the political and ideological context of a state wracked by the growing pains of a new geopolitical role. That the American state took time to develop its hegemonic role is understandable; what is surprising is the disparity between the fits and starts analyzed here and the totality of the
technodiplomatic identity that the country projected in the 1960s. If the Space Age United States portrayed itself as a confident technological superpower, a look at its history in the first years after World War II proved that, until extremely recently, it had been anything but.

While the British exchange and the successes of the Manhattan Project and Vannevar Bush's OSRD convinced certain key actors—the Tizard Generation—that science and technology were critical functions of government in the modern world, the unusual powers granted to the executive and to unaccountable fiefdoms like the OSRD were nevertheless set to lapse with the close of hostilities. As a result, advocates for and participants in what had become a multibillion dollar industry suddenly found themselves answerable to a broader public, susceptible to the vagaries of boilerplate right-versus-left politics, and vulnerable to views about the nature of the American state that both predated the war and survived it in a surprisingly persistent way.

The acceptance of new paradigms in the face of weighty historical momentum is seldom simple or quick. As we saw in Chapters One and Two, the Second World War represented an extraordinary pivot towards an ideology equating state-driven technoscientific capacity with national power in the United States—but only among certain historical actors and certain sectors of government. That group of actors was vocal, steadily growing, and included the likes of eminent public figures and presidents, but it was still often boxed-in and frustrated, year after year, well into the period in which a technoscientific elite was supposed to have begun manipulating the levers of American power.
The remaining three chapters are about that small but growing cadre of technoscience champions, as well as their discontents. In the face of a changing geopolitical context abroad and an evolving partisan landscape at home, these people lobbied for, nurtured, and shaped their doctrine in the face of considerable bureaucratic and political obstacles. Many derived their ideas from the pivot of World War II and the experience of the OSRD. And many—but not all—had worked directly with the British exchange, or been involved in the Manhattan Project.

We should not view these proponents of technoscience-as-power as a monolithic or cohesive group. Rather, they came from different milieus, played diverse roles in the public commons, and had varying degrees of clout and influence. Many may not have claimed to work for the cause of technoscience at all—and indeed some worked in ways that were counterproductive to it, inadvertently or otherwise. Rather, we can unite them in hindsight, as grapplers with a new marker of global power in an age when the U.S. government was growing and mutating in ways unrecognizable to previous generations, and when the nation was plunging into a new global position whose basis and future was far from certain.

Like the ideologies and politics themselves, this chapter is multilayered, visiting and analyzing the disparate areas of public life that debates about the relationship between technology and global power began to touch in the postwar period.

First, the chapter discusses the ways in which a growing faith in the significance of American science and technology at times paradoxically served to militate against the dedication of further
public resources to it in the years after the war. The secrecy of the wartime R&D bureaucracy, combined with the boom of triumphalist self-promotion by private industry that arose during and after the war, tended to feed the notion that American technology was a self-generating product of the national character, and born of private dynamism. Well into the Cold War, political debates about the establishment and growth of federal research bureaucracies continued to allegorize the laissez-faire successes of 'private geniuses' like Thomas Edison and the capitalist drama of the Second Industrial Revolution. These tropes demonstrated that—even among those growing numbers who were aware of the new technological age and proud of American leadership in it—stark divisions continued to persist as to whether any significant political changes were actually needed to ensure continuity of the nation’s global leadership in this vital area.8

The contours of these debates were shaped further by the ways that science and technology had evolved during the war, bringing the muscle and prominence of large companies into the highest realms of state decisionmaking and operations. The particular manner with which the OSRD and military funneled development money to the private sector meant that, by war’s end, 40 percent of all government R&D money had gone to just ten corporations, and more than 90 percent of those had been allowed to keep the resulting intellectual property as their own.9 In Chapter Two we saw how large firms muscled commercial advantages from British science, but industrial interests were

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fundamentally entangled in the decisionmaking of American agencies, as well. As this chapter will show, this entanglement was most dramatically evident in the prosecution of secretive programs to seek, acquire, and indigenize Nazi high technology at the end of the war. Agents of programs like Operation Paperclip—the repatriation and exploitation of German researchers for U.S. purposes—and FIAT—the massive gathering of secret Nazi materials, equipment, and documents—were heavily influenced by representatives of large corporations, whose quibbles with Nazism were far overshadowed by their desire to accrue German secrets for the benefit of their companies back home. Their self-interested machinations flew in the face of government administrators’ public-minded plans for programs like the Alien Property Custodian, a centralized government bureau aimed at the free dissemination of enemy intellectual property. The chief priority of these operations thus became to ensure that commercial rivals overseas—including in allied Britain and France—could not gain advantages over American industry through the exploitation of German technology. This private impulse was a roadblock to U.S. state technoscience, one that diverged considerably from the more centralized schemes conducted in London and Moscow.

Meanwhile, the implantation of a robust scientific and technological state complex was just as fraught in the domestic political realm. Here I borrow a concept from Thomas Hughes, using the military metaphor of the “reverse salient,” a term describing aspects of large systems that hold back, delay, or limit the advance of the whole. I argue that the primary “reverse salient” in the advance of state technoscience in the first decade after the Second World War was the U.S. Congress, harboring

as it did many traditionalist politicians alarmed at the sudden statebuilding around them, and uninterested in supporting new initiatives in research and development. Some of these politicians sought openly to limit funding for science and technology in the public sector. Others were aware of its power but vacillated for years to commit resources to it, betraying a clear lack of priority despite a darkening geopolitical context. Still others were skeptical of partially absorbing into the state a sector that had seemingly been conducted to great success by private industry and nonstate actors for years.

This chapter will use the yearslong debate about the establishment and trajectory of the National Science Foundation as a lens through which to view these conflicts and contradictions. Of course, the controversy surrounding the creation of the NSF is hardly new in science historiography. It has been suggested by other scholars that the five-year delay between VJ Day and the creation of the NSF pushed scientists into the thrall of the military. The NSF’s own agency history, meanwhile, notes that the new relationship between government and researchers effectuated by the war simply “disallowed a return to prewar times” and created a new paradigm of state-driven R&D.\footnote{George T. Mazuzan, “The National Science Foundation: A Brief History,” Washington, D.C.: National Science Foundation, July 15, 1994, \url{https://www.nsf.gov/about/history/nsf50/nsf8816.jsp}. See Forman, “Behind Quantum Electronics,” and Kevles, “Cold War and Hot Physics,” in addition to the many responses to their claims in the ensuing decades, as detailed in this dissertation’s introduction.} My discussion of the NSF and its formative manifesto, Science: The Endless Frontier, takes slightly a different tack. First, I show that debates around the NSF help us to understand the ways that Americans conflated “science” with “technology,” partly fueled by industry-driven popular cultural forms, and partly by the efforts of NSF supporters themselves to sell the nation on the need for “science” by dangling the carrot of national strength derived from U.S. “technology.” Having
established this, I will argue that, given this conflation, the lack of political commitment for the support of a public science foundation—and the ongoing attempts to undermine it and sap it of resources through the late 1950s—demonstrated that partisan divides took clear political precedence over the notion that the nation’s technological capacity equated with international power. Despite the best efforts of technoscience champions, debates on civilian R&D still followed the contours of domestic political categories, rather than international ones.

As NACA chairman Jerome Hunsaker noted after a series of unsavory run-ins with legislators in 1947, “I suppose we must accept the view that our democratic form of government is highly exasperating until the education of those in key positions permits the adoption of a consistent and recognizable policy.” Rallying fellow advocates for science and technology, Hunsaker noted that “visibility under such circumstances is poor, and we have go to look ahead and look sharp. There is a way ahead but it is not easy.”12 Before the late 1950s, the rise of a technoscientific elite in the United States was far from guaranteed.

‘Yankee ingenuity’ on the factory floor

Writing on the coming peace in 1944, the president of the RCA Corporation, David Sarnoff, explained to Americans that “our hope for a future world economy of abundance” stemmed not from the memory of prewar standards of prosperity, but rather from new “promises of industrial science,

which in many instances the war has already brought to rapid fulfillment.” Citing advancements in housing, transportation, communication, refrigeration, and the “most spectacular development” of television, Sarnoff assured readers that “the new frontiers are those of science. The covered wagon of the present day is the research laboratory.” Industrialists, like civil servants, were keen to seize on the language of the frontier to promote the dawning technological future.

As we saw in Chapter 2, American industry took great pains to frame itself as the engine of innovation most responsible for victory in the war. In doing so, it not only forged an idealized patriotic narrative of the power of private dynamism, but also helped to exacerbate a blurry public understanding of the nature and process of technoscience, one that would have a cascading effect on the bureaucratic and political development of state research and development in the coming years.

The drama of the war had already laid the groundwork for a new public spotlight and new national narratives about science and technology. Dazzling technologies of victory, and the material promise of the future once swords were beaten into ploughshares, were topics increasingly in vogue in the mass media during the mid-1940s. No sooner did the public become aware of the atomic bombing of Japan, for example, than MGM put a dramatized film account of the Manhattan Project into production—The Beginning or the End premiered in February 1947, featuring actor Jonathan Hale as Vannevar Bush. A dramatic official popular history of the OSRD, Scientists against Time, hit bookshelves less than a year after VJ Day, and netted its author, James Phinney Baxter III, a Pulitzer

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14 Letter, Vannevar Bush to Dr. J.B. Conant, November 4, 1946. Vannevar Bush papers, box 27, LoC.

Industrial narratives leveraged these irrepressibly abundant examples of high technology into a blanket rhetorical concept of American “science,” which had the effect of flattening abstract and academic laboratory work into the commercially-available fruits of corporate factories in the public eye. The nameless “scientist”—the new character Jackson Lears has called the white-coated “modern magus”—became the ultimate symbolic salesperson for industrial firms, providing an assumed authority and implied objectivity in judging industrial technologies against each other.17 The impartial “man of learning” in the laboratory was now working not on fundamental concepts, but rather on the miracle technologies and creature comforts of tomorrow. Arguments for taxpayer-supported laboratory research, then, especially when it came to the ‘basic’ variety that lacked direct applications, ran up against industrial appropriation of the combined concepts of science and technology. Anti-New Deal discourses about the vitality of the American private sector called into

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question the need of government to foster what was becoming a newly prominent marker of U.S. strength.

Amidst the reams of glossy advertisements extolling the futuristic new directions of American free enterprise, corporate advertisers even suggested that academic scientists themselves had a thing or two to learn from industry. In a “Note for professors,” the industrial magazine Nation’s Business admonished academics for “know[ing] their facts,” but “writ[ing] them in a language that no laymen can unravel.” Why, wondered the editors, did scholars not look to Arthur D. Little’s Industrial Bulletin to learn how to explain to the public the real use of pure science (defined here as “the abstract work in laboratories which may finally trickle out in such things as nylon hosiery”)? Similarly, in an engineering conference at Purdue University, an industrial presentation framed the technology of the war as evidence of the crucial need to continue to rely on private science. From radar to quick-freezing meals, boasted the New York Air Brake Company’s L.K. Sillcox, “industry accepts its responsibility to the public, to consumers, to labor, and to capital for making helpful progress possible in the future… If scientific experimentation in industry is continued we shall have widespread adoption of new productive processes, new resources, and still better standards of living.”

This haphazard conflation of basic science, application, development, technology, living standards, and industrial research—as well as the growing acceptance of that conflation as “science”

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18 “NB Notebook: Note for Professors,” Nation’s Business vol. 33, no. 4, (U.S. Chamber of Commerce), April 1945, http://digital.hagley.org/islandora/object/islandora%3A2135920#page/7/mode/1up
19 Address, L.K. Sillcox, “Engineering Evolution from War to a Peacetime World,” Purdue University, Lafayette, Ind., December 5, 1945, Vannevar Bush papers, box 103, LoC.
in the public imagination—drove scientists themselves to distraction. As the Office of Naval Research’s Alan Waterman lamented, the corporate advertising industry “not only spurious identifies the scientist with a host of commercial products but often succeeds, in the process, in making him something of a figure of fun.” This characterization trivialized science for the masses and distorted their understanding of the research process.20

The private-sector wrestling of narratives of technoscience was not limited only to the lay public. It also echoed in the halls of political power. During the 1953 round of congressional appropriations hearings, for example, Senator Pat McCarran—the long-serving Nevadan who became known as the “Father of Civil Aviation” for his legislative advocacy—criticized the research budget of the Department of Defense, saying it had thus far failed to produce any innovations of value.21 The Air Force general being questioned replied that the B-47 and B-52 bombers had been great successes, to which McCarran shot back that those were inappropriate examples, since they were the products of private enterprise. The astonished general thus had to carefully explain to one of the most technologically invested politicians in the nation that U.S. air power was “not invented by private enterprise in the sense that Edison invented the electric light, [and] neither was their invention merely paid for by the federal government, in the way in which it pays for so many trucks

or typewriters.”22 The need for state support for science and technology—even when supporting the military—was not always a given to those who held the pursestrings.

Corporate leaders also saw the strategic appeal of tapping into growing discourses of global leadership. In 1946, Chamber of Commerce president W. K. Jackson took to newspapers to stress how Corporate America would henceforth be responsible for advances in standards of living not only in the U.S., but abroad. Drawing a contrast to the “spread of statism in Europe,” Jackson noted that in “helping the post-war recovery of a war-ravaged world, the American enterprise system has a task second only to the task of producing victory in war.” By strategically playing on the language of ongoing international responsibility, business leaders implied the need to continue the favorable regulatory paradigm that had marked the wartime emergency. In particular, with the enormous revitalization of labor activism after VJ Day, it behooved industrialists to present their firms to policymakers and the public as indispensable to the technological aspects of victory, recovery, and innovation. “The American people want uninterrupted and expanding industrial production,” Jackson said. The choice was between their technological goods and their unions.23

What, then, did this brand of promotion mean overall for the notion that U.S. strength derived from its technoscience? It is important to note that for all the discursive construction of the scientist-as-magus, these were years in which technological breakthroughs were beginning to accrue to Americans’ everyday lives, with standards of living increasing in the midcentury decades at an


ever-accelerating pace. Corporations’ claims over this progress did much to naturalize and reify a revived notion of Yankee ingenuity—of wizards in laboratories engendering strength abroad and comfort at home. The British exchange was now essentially forgotten, of course, but where the advances came from was rarely the point: no matter if it was industrial laboratories, military testing facilities, government bureaucracies, or universities, American material genius seemed pervasive and innate, and the importance of science and technology to national welfare and strength had now become a commonplace. A new, futuristic world of technology was dawning, and American genius was poised to lead it.

**Patents and Paperclips**

As these industrial narratives suggest, the United States had measured its place in the world during the prewar period by the relative strength of its industrial juggernaut. Indeed, this positioning, based on U.S. industrial output and innovation, had become an increasingly deeply ingrained worldview for Americans for more than half a century. It was therefore natural that, despite the dramatic swerve into new diplomatic, material, and statebuilding territory that the Second World War represented, many still turned to the future by instinctively looking through a traditional lens in which private industry equated to national power. The historical record shows this impulse dominating thinking about how ultimately to maintain U.S. power in several strategic arenas from about 1942 to the first year or two after the war, when the Cold War began to freeze over.

One notable illustration of this persistent impulse was the cluster of efforts to seize Nazi research and development advances and expertise. These began with raids behind enemy lines, but
reached fever pitch as the Allies conquered their way towards Berlin. The U.S., like Britain and the Soviet Union, expended considerable energy safeguarding Axis intellectual property and transferring it back to the homeland. But a program that began as an attempt to ensure that advanced German research—especially in the realm of nuclear physics—could not be developed further or fall into belligerent hands, quickly took on a role of trying to prevent other countries from reaping commercial advantages. Moreover, the data and knowledge that was acquired often ended up in the hands of corporations, rather than the state. It is a pattern we see in all major efforts to acquire Nazi science, including Operation Paperclip, FIAT, and the Alien Property Custodian.

Operation Paperclip was a wide-ranging effort by the American intelligence community—and specifically, the wartime Joint Intelligence Objectives Agency—to repatriate Nazi scientists and their families to the United States, ‘cleanse’ their war records, and mobilize their expertise for American scientific purposes. Paperclip has become well known, and is usually interpreted as a project by and for the state security apparatus. This view hinges especially on the importation of Wernher von Braun and his fellow rocket scientists, who were central to both the development of

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24 It is worth reiterating that the primary technological fallout of the First World War had been a raft of litigation, squabbling over patents, and jockeying for intellectual property spoils on the part of the private industry concerns from the various belligerents. It is understandable, then, that as a new peace approached a degree of reflexive institutional memory was triggered, including a corporate aim to emerge in better commercial stead than last time. See this dissertation, Chapter 1. For a primary source from the debate on morality, war, and intellectual property from the period, see Engelbrecht and Hanighen, *The Merchants of Death*; see also Kate Epstein, *Torpedo: Inventing the Military-Industrial Complex in the United States and Great Britain* (Cambridge, Mass.: Harvard University Press, 2015); Mark Wilson, *Destructive Creation*; and Jonathan Winkler, *Nexus: Strategic Communications and American Security in World War I* (Cambridge, Mass.: Harvard University Press, 2008).
ICBMs and the space race in the decades ahead. What the ‘security’ interpretation leaves out, however, is that many Paperclip personnel were ambitious industrial representatives with more prosaic motives. Far from simply undergirding American security, the program often served to funnel people and secrets directly to the American private sector.

It is tempting, given that the dragnet of scientists was primarily targeted at Soviet occupation zones in eastern Germany, to chalk Operation Paperclip up to the earliest rumblings of Cold War gamesmanship. In reality, however, many American officials were concerned with the dispersion of scientific talent and output to places well beyond the Soviet bloc, especially to foreign commercial competitors. Of particular worry to the American occupying force was the risk that allied Britain, France, and the Soviet Union would beat the U.S. to the sequestration of talented Germans, both for their contributions to weaponry and the “development of technical inventions for industrial use.” Early reports even suggested that Spain, Switzerland, Egypt, Iraq, Argentina, and other Latin American nations would also provide havens for the researchers. In most such cases, internal

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Truman administration communications betray a fear of losing these Germans’ benefit to U.S. science and industry.\textsuperscript{27}

Field reports in the weeks after the fall of Berlin suggested that not only were there more than 75 freight carloads of “extremely valuable laboratory equipment”—including a complete supersonic wind tunnel—just waiting to be poached in the American zone alone, but also that the U.S. was not the only one doing the poaching. As a Naval field memorandum noted, “the urgency is immediate, as all alert intelligence officers and the [European command] are seeking scientific personnel or equipment.”\textsuperscript{28} It is true, of course, that much concern stemmed from the leakage of German atomic advancements to Moscow and beyond, but other motivations were mercenary in nature. American intelligence operatives noted that “many government departments and independent agencies urgently desire to exploit these specialists in the United States… Great Britain, France, and the USSR will proceed unilaterally to exploit Germans for civil purposes whether or not the U.S. [does] so.”\textsuperscript{29}

These reports were not wrong: Within a year, a NACA mission to London alerted Washington that the British Ministry of Supply was already disseminating sophisticated German aeronautical data to a variety of firms.\textsuperscript{30}

\textsuperscript{28} Memorandum, Rear Admiral J.A. Furer to Admiral R.S. Edwards, “German Scientists and Laboratory Equipment,” May 30, 1943. RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 24, NARA.
\textsuperscript{29} Gimbel, “U.S. Policy and German Scientists,” 446. Emphasis mine.
\textsuperscript{30} Report, J.C. Hunsaker, NACA to Vannevar Bush, August 12, 1946, box 82, Vannevar Bush papers, LoC.
U.S. officials quickly instituted analogous programs to help American industry. In August 1945, the War Department transferred its program of disseminating declassified scientific and technical information to the Department of Commerce in order to facilitate the process, and in January 1946 did the same with its Technical Industrial Intelligence Branch (TIIB). This gave hundreds of overseas investigators—comprised in large part of collection staff from industry, sworn in as unpaid temporary government employees—carte blanche to vacuum up blueprints and reports for use by the American private sector. The program was sponsored by the Office of Publication Board, but because the lucrative TIIB did not have sufficient investigators to satisfy corporate demands, the companies began funding the intelligence operation themselves.\(^3\) The industrial agents toured factories, grilled German personnel and, most valuably, shipped enormous quantities of machinery back to the U.S. to be reverse-engineered and “tested to destruction.” The Office of War Mobilization and Reconversion considered this to be “one of the best ways to determine whether enemy techniques are of sufficient value to warrant their adoption by American science and industry.”\(^3\)

Deference to industry was present in these operations from the beginning. Indeed, the first collection teams that fanned out across Europe in 1944 as part of the Anglo-American Combined Intelligence Objectives Subcommittee (CIOS) included many experts drawn from the private sector, who returned to the United States with lists of Germans they wished to try to import for the benefit

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\(^3\) Letter, John W. Snyder, Office of War Mobilization and Reconversion, to Harold Smith, Bureau of the Budget, May 22, 1946. RG227, OSRD, Records of the Liaison Office, entry 168, box 22, NARA.
of their own industries. Corporate lobbying soon followed, with industry pressure on Senators trickling up to the Truman administration. As one company president wrote to the Navy, the U.S. simply had to beat Russia in making permanent use of the “world’s greatest scientists and technicians,” since there was little doubt that “American industry and institutions would be glad to employ these men.”

Of course, given the fraught politics of hiring Nazi scientists, the administration had to tread carefully. One solution was to frame the transfer as purely security related. In October 1945, the War Department issued a carefully worded public statement soft-pedaling the implications of importing Nazi researchers, instead framing the program as “ensur[ing] that we take full advantage of those significant developments which are deemed vital to our national security.” Scientists were simply being brought to the U.S., the Army said, “in order that this country may benefit fully from this resource.”

Public interest in German R&D quickly took root—and just as quickly, began to blur the line between vital security concerns and corporate benefit. A whimsical 1946 article in Harper’s, for example, romped through numerous vignettes of high-tech industrialists emerging from meetings flabbergasted by what the military was happy to give them for free from its German take. “Someone

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34 Letter, Al Baxter, Essar Research and Development Co., to Office of Secretary of the Navy, April (?) 1945, RG298 (ONR), stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 12, NARA.
35 Gimbel, “Project Paperclip,” 350
wrote to Wright Field recently,” the article recounted, “saying he understood this country had got together quite a collection of enemy war secrets, that many were now on public sale, and could he, please, be sent everything on German jet engines. The Air Documents Division of the Army Air Forces answered: ‘Sorry—but that would be fifty tons.’” “Thanks very much,” said another industrialist as he left a consultation with the Office of Technical Services, “the notes from these documents are worth at least half a million dollars to my company.”  

So soon after the New Deal, the government was mindful of avoiding perceptions of corporate welfare. The TIIB program, for example, originally included provisions to try to equitably distribute German secrets in the United States. Free transportation and lodging for industrial collectors, provided by the Army, was offered in exchange for agreement that any information obtained would be summarized in writing to the TIIB and made available to the general public. Moreover, agents from competing companies were paired up in the occupation zone to try to prevent off-the-record sequestration of data.  

The de facto successor to CIOS, the Field Information Agency, Technical (FIAT), was created to centrally coordinate the various agencies, branches, and interests combing the ravaged European theater for technological secrets. Here again, many FIAT investigators were actually officials from private corporations, smuggling much of the secret know-how they could find back to their own

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businesses, rather than pooling them for open publication.\textsuperscript{39} As intelligence personnel completed their work in late 1945, FIAT became primarily a civilian operation, with private microfilming teams scouring the country for usable data. By mid-1946, FIAT had collected 53 tons of documents—over 23,000 reports—to send back to the U.S.\textsuperscript{40} The siphoning became so exploitative—possibly to the tune of $10 billion in intellectual property—that it eventually ran afoul of the policy of High Commissioner to Germany Lucius Clay, who thought that after VJ Day the United States’s scientific collection in Germany had moved “squarely into the commercial field.” Clay noted that “We are perhaps doing the same thing that Russia is doing in taking current production … and that France is doing in removing capital equipment from Germany.” Eventually Clay feared the long-term damage such a unidirectional siphoning of technical knowledge would wreak upon the reconstruction of Germany. The party was over—FIAT was folded in June 1947.\textsuperscript{41}

Ultimately, the collection of technological data proved more successful than the exploitation of German personnel themselves. As John Gimbel notes, bureaucratic entanglements, administrative restrictions, and redirected intelligence priorities squandered many of the potential gains of Operation Paperclip, as some of “Germany’s more productive minds” were essentially “kept on ice” for three years. But this did not particularly aggrieve American officials, as one of the program’s primary intentions—to assuage “fears that the British, the French, or the Russians would get to them


\textsuperscript{41} Gimbel, \textit{Science, Technology, and Reparations}, viii.
first”—had been achieved. Keeping the scientists out of commercial rivals’ hands—even those of current allies—thus turned out to be more important than actually extracting their scientific talent for use by the American security state.

But if industry was so effective in influencing the technological activities of the state in occupied Germany, what of the exploitation of the secrets back home? Here, too, efforts by the American state to indigenize German knowledge betrayed a continued adherence to prewar political debates about the rights of private enterprise. The tight integration of industrialists into the prosecution of war programs, moreover, continued to encumber absorption of foreign secrets into the state itself. Even those activities that the state did undertake increasingly turned into a boondoggle for large firms, as the liberal policy goals of the New Deal gave way to a lucrative new language of national security. In short, in the wartime handling of foreign intellectual property, we see both a dawning recognition of the importance of R&D to U.S. strength, and a stubborn persistence of the notion that private industry, rather than a centralized technological command, would continue to form the basis for American hegemony.

In March 1942, President Roosevelt established the Alien Property Custodian, an emergency war office whose role was to transfer a firehose torrent of Axis patents to American firms and producers. This was no small matter—the seized innovations amounted to more than ten thousand individual pieces of intellectual property, many of them cutting-edge and superior to those possessed

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by U.S. industry. They also drew from an enormous range of fields, from plastics and food science to metallurgy and pharmaceuticals.  

By early 1943 the APC was urging businesses to take as much advantage of the seized patents as possible. The office wrote to the OSRD, for example, to beg it to distribute royalty-free patents to any relevant manufacturers who might make use of them. The Custodian circulated a glossy brochure, “Patents at Work,” noting that U.S. scientists and engineers were freely welcome to avail themselves of the latest automobile inventions of Daimler-Benz and Fiat, the state of the art armaments of Schneider et Cie and Skoda, and the advanced Japanese electronic components of Kwaisha Toden Denkuy Kabushiki. The application process was simple—just send in a form with a list of desired patents and enclose a $50 application fee (plus $5 for every extra patent). Even better, if any technical assistance was needed for the use of the concepts, the APC central office in Chicago was ready with expert help and advice.

Leveraging this mountain of intellectual property, the APC believed, would be crucial to postwar American greatness. The full exploitation of royalty-free patents by American firms would not only destroy the enemy, but would also “produce the material well-being which in post-war years will form a strong bulwark of the free world for which we now struggle.” Envisioning an ascendance of U.S. research and development over that of former international rivals, the APC’s program

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44 Alien Property Custodian, “Patents At Work,” January 1943, RG227, Entry 169 (NC-138), box 41, NARA.
promised to “strengthen the technological resources of America for that day when we turn again in a better world to the tasks of peace.”

The APC operated under the purview of the Commerce Department, led by the strident New Dealer (and former vice president to Franklin Roosevelt), Henry Wallace. Given his intended designs for a redistributive and democratic APC program, Wallace fits neatly among the cadre of technoscience champions burgeoning in this period. In Wallace’s view, the APC was a way to use science and technology to revive the New Deal by creating an open pool of royalty-free knowledge available to any producer that wanted it, large or small—especially small. This belief is noteworthy in its duality: On one hand, it clearly betrays an awakening at the elite policymaking level to the power of science and technology to foster American welfare, yet at the same time, it persisted in adhering to a domestic, prewar political platform of socioeconomic leveling and antimonopolism.

But Wallace’s progressive hopes were no match for the industrial interests that the war had brought into U.S. science and technology policy. The acquisition of foreign high technology seemed to be yet another advantage for those corporations in best position to exploit it. Small firms howled, including directly to Congress, that “large business has heretofore held a virtual monopoly on practically all research and development, which has in many cases been used to the detriment of small business.” Major corporations enjoyed favorable taxation structures, one Washington business owner complained, which allowed them to plough profits tax-free into R&D, thus increasing the gap

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45 Ibid.
between the haves and have-nots in research.\textsuperscript{47} Despite these pleas, however, large firms continued freely to feed off the Nazi scientific carcass. Boeing used German wind-tunnel data for new jet aircraft, for example, while the American Chemical Foundation profited from chemical and dye patents. At the same time, imports of the same goods from Germany were banned, on the premise that they infringed on what were now legally \textit{American} patents. In a final blow to Wallace’s New Deal vision for the APC, the incoming Republican congress cut the program’s funding in 1947. Any hopes that the program could be used to inculcate high technology among small producers quickly fizzled.\textsuperscript{48}

The saga of Paperclip, FIAT, and the APC reveals several things about late-war and early-postwar United States. The first is that the lesson of the war regarding the importance of science and technology to both public and private power was clearly sinking in, and doing so across political and economic spectra—from corporate boardrooms to military war rooms to the White House. The second is that neither the war in Japan nor the darkening relationship with the Soviet Union were the only things on most technology-collectors’ minds. Rather, it was just as important to keep both military and commercial secrets from \textit{allies} like Britain and France as it was to develop the United States’s own capacity, even if it meant squandering the talents of the German researchers involved. Regardless, the hoovering of German secrets demonstrates a newly conscious technoscientific


engagement with the world, something that would have been alien to the country following the previous war, for example.

Finally, these episodes reveal the ongoing political limitations of U.S. state technology. New Deal-era debates about overconcentration of wealth and the evils of industry were still very much alive, and the dramatic rampup of technoscience—for the moment—seemed to slot into those debates neatly. The Roosevelt administration’s strategy to court big business into a public-private wartime collaboration only served to hamper implantation of new scientific and technological knowledge into the state.\textsuperscript{49}

Debates on these same lines would soon shift to Capitol Hill.

\textbf{The Curious Career of the National Science Foundation}

Technoscience promoters like OSRD chief Vannevar Bush faced a difficult task at the end of the Second World War. On one hand, science and technology were on the nation’s lips perhaps more than ever before in the nation’s history. The war had provided a dazzling, patriotic spectacle of research in action, of the nation’s laboratories and high-tech factories geared toward national greatness. With a little help from friends in Britain, Bush’s lifelong mission to convince wide swaths

of military and other government officials of the value of science to the country’s progress had seemingly come to fruition.

On the other hand, as we have seen, these years were pervaded by both abstract narratives and a practical political mobilization that served to propagate a sense that the United States was already the global technological leader, possessed of an innate advantage through its genius and industry. This belief flew in the face of pleas from people like Bush that the state needed now more than ever to take sweeping action to commit new and unprecedented public resources to technoscience.

It was a difficult argument to make, shot through with nuance and murk, and seemingly contradictory to anybody without a firm command of prevailing beliefs about how science worked. How to explain in layman’s terms that American technological greatness had won the war, yet had been based to a hazardous degree on foreign science; that science itself was not the same thing as technology; and that high-tech industrial output was crucial to the nation’s future global leadership, and now needed a muscular intervention from the state to keep on track? This was complex stuff, not an ideology made for bumper stickers.

The late Thomas Hughes used the concept of “reverse salients” to explain elements of technological systems that hold back an advancing front. A reverse salient, he wrote, “appears in an expanding system when a component of the system does not march along harmoniously with other components… As a result of the reverse salient, growth of the entire enterprise is hampered, or
thwarted, and thus remedial action is required.” Applying this concept to the public and political realm of the early postwar United States, the historical record suggests that the reverse salient in the implantation of an ideology of technoscientific global power and the need for a robust, civilian-oriented state complex of R&D was the U.S. Congress.

Debates about science and technology during and immediately after the war were inflected with persisting New Deal-era political divisions about the role of government. During the war this was perhaps understandable, as the dramatic changes to the government’s R&D mechanisms outpaced changes in political thinking. The majority of politicians, agency heads, policy thinkers, and administrators, after all, had been ideologically incubated before the war, sometimes decades before it. So it is logical that the creaking machinery of Washington could not pivot as fast as new research developments were coming out of the nation’s new laboratories. But as we will also see, in the decade after the war, this reluctance toward state expansion—and the persistence of earlier political assumptions—continued to clash with the demands of the country’s changing place in the world. The result was an overarching paralysis that did much to impede the Tizard Generation’s vision of an open and civilian-controlled implantation of technoscience into the U.S. state.

While the OSRD, the military laboratories, and the British did their work at a dizzying pace, by the time the U.S. fully mobilized for the war the notion of state technology had begun to trickle into the public political sphere along a blatantly 1930s paradigm, fitting quite neatly into the contours of debates about the New Deal. In particular, the drama of the OSRD roused liberals and New

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50 Hughes, *Networks of Power*, 79
Dealers to the power of R&D to achieve existing political goals, in ways they had not considered before the war. Although these New Dealers did awake to the power of technoscience, however, it was not yet an international category of global power for them. Rather, theirs was a fundamentally domestic politics, meaning that it could be impaled on the spikes of domestic conflicts, rather than merged into a foreign policy consensus as the nation pivoted towards a new international responsibility.

Perhaps predictably, part of liberals’ earliest motivation for exploring state technology came as a reaction to the industrial self-promotion that we have previously seen, something they considered an affront. A core of liberal Congressmen eyed the avalanche of utopian commercial advertising and noted that the role of government in underwriting industry’s wartime miracles tended to go conspicuously unmentioned. Fearing a repeat of the aftermath of the First World War—in which taxpayer-funded windfalls like the Navy’s radio patents were channeled to large corporations like RCA—the Senate’s War Mobilization Subcommittee began hearings in October 1943 to explore how to direct the enormous federal mobilization of science and industry toward the public good. The primary champion of this liberalizing effort was the subcommittee’s chairman, the charismatic West Virginia Senator, Harley M. Kilgore.

Gregarious, witty, and outspoken, Kilgore entered the Senate in 1941 as a progressive favorite. He befriended Harry Truman, and was appointed to Truman’s special investigative committee on

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industrial fraud, waste, and war profiteering. By October 1942 Kilgore was given his own Subcommittee of War Mobilization. Under his direction, this body investigated prewar cartelization and collusion with Japan by U.S. technology firms, finding that in the years leading up to Pearl Harbor, “a constant stream of information flowed to Japan” from American companies like Boeing, Douglas, and Universal Oil. Damningly, Kilgore found that these companies had brazenly divulged state strategic secrets to companies like Mitsubishi, and clandestinely participated in dealings in third-party locations like Mexico to circumvent trade embargoes.

As these investigations suggest, Kilgore’s politics were solidly grounded in the tradition of populism, and his partisan priorities were antimonopolism and latter-day trust-busting. Kilgore wasn’t well-versed in science and technology—indeed, he professed an “utter, absolute ignorance” on the matter—but he joined other liberals like Wallace (then still vice president) in alarm at the potential power of R&D to concentrate political and economic clout in the hands of large corporations. Their New Deal worldviews led them to decide that if the state could develop its own scientific capacity, the monopolizing tendencies of large-scale research could be dismantled and fair competition restored.

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53 Maddox, “Senator Harley M. Kilgore and Japan’s World War II Business Practices.”

In the summer of 1942, Kilgore, together with Senator Claude Pepper of Florida, introduced his Technology Mobilization Act. A vessel for idealistic New Deal populism, Kilgore’s proposal quickly received the support of Wallace, trust-busting attorney general Thurman Arnold, and other establishment liberals. Reintroduced the following year, the law proposed the establishment of a superagency, the Office of Technology Mobilization, which would centralize the application of national science and technology resources in both peace and wartime. The Office was to represent “a permanent department of science and technology in the Government, for the furtherance of experimenting and for the dissemination of important processes, important ideas, into industry as a whole, rather than the creation of monopolies based on important processes.”

As this language shows, Kilgore’s focus for the bills was the populist ideals of fairness and distribution of intellectual property, rather than the mechanics of fostering a program of state technoscience itself. In committee hearings, Kilgore repeatedly pressed his witnesses to affirm his belief in the possibilities for government research to lift all boats. To the frustration of science administrators like Bush, he insisted on emphasizing the testimony of private inventors, who argued

58 Ibid., p. 493.
that the cartel-like way that government and big business had mobilized R&D for the war was hopelessly inequitable.59

One of Kilgore’s key invitees was the pioneering popular science writer and interpreter Waldemar Kaempfert, then in his second stint at the New York Times. Guided by a series of leading questions from Kilgore, Kaempfert described how the U.S. government had spent decades “drift[ing] along aimlessly” in science engagement, especially in comparison to European states. While Britain, Russia, and Germany poured public resources into a broad front of research and development, the U.S. ceded its own science to the profit motives of industry, which overconcentrated resources into the lucrative fields of applied chemistry and physics. Why, wondered Kaempfert, did the American state allow the “laissez faire policy which is now outmoded in economics” nevertheless to persist in science and technology? Ultimately, the United States government needed to mobilize research for the common good, to “secure social security, social happiness, and contentment.” Kilgore’s bill, he noted, was the first attempt made in the country to look at science and technology in this way.60

While we can thus consider Kilgore as a central force among the new cadre of U.S. technoscience champions—and his legislative efforts were certainly unprecedented in this arena at the time—we must also underscore that his designs for science and technology were nevertheless wedged into prewar, domestic modes of political thought and argumentation, and therefore susceptible to prewar, domestic counterarguments. And those quickly came. Censorious reaction to

S.702 from the military, the OSRD, and from organized groups like the American Institute of Physics, quickly quashed the initiative.616263

Opponents of the bill, like its supporters, looked at the growth of U.S. technoscience through a prewar lens. They did not find fault only with S.702’s administrative and conceptual shortcomings, but also with its New Deal statism. An internal Navy memo, for example, complained that the peacetime provisions of this “shot-gun legislation” were “in violent conflict with strongly entrenched American ideas of private rights that are fundamental to a democracy.” The bill, it warned, could establish a “bridgehead for forces that wish to invade free enterprise,” and could even be a cloaked plan for a Trotskyist “managerial revolution” in America.64

Industrialists reacted with similar vigor. F. C. Jones, president of the Okonite Callender Cable Company of Paterson, New Jersey, wrote to Kilgore that the bill was using the war as an excuse to take the “first great step to socialize and nationalize all industry.” The “vicious, socialistic” legislation “would create the most despotic authority ever given to a single officer” and “would wreck our

61 Letter, James Forrestal to Senator Kilgore, April 19, 1943, Office of Naval Research papers, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
62 “Resolution Passed by the War Policy Committee,” American Institute of Physics, May 8, 1943, Office of Naval Research papers, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
63 Memorandum, Lybrand Smith, Capt., USN (Ret.) for Rear Admiral Furer, USN, March 19, 1943, Office of Naval Research papers, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
national economy." 65 Jones’s letter was circulated by the National Electrical Manufacturer’s Association in the hopes that members would in turn write to their own representatives about the bill. 66 Meanwhile, L. A. Hawkins, executive engineer for General Electric’s Schenectady laboratory, provided an analysis that was slightly less shrill but no less damning. S.702, he wrote, was not only based on false premises, but in implementing its proposals would be mischievous, undemocratic, confiscatory, and rapacious. In short, he declared, “insofar as it is not destructive, it is useless; insofar as it is not useless, it is destructive.” G.E.’s Vice President, William Coolidge, promptly sent Hawkins’s analysis to the Navy’s chief research officer in Washington. 67

On the Senate floor, Kilgore and his cohort fought back in vain, repeating their blistering accusations of corporate malfeasance. Although their designs ultimately failed, their changing rhetoric shows in real-time a version of the dawning ideology of technoscience. In one illustrative instance, Kilgore brought out the trust-busting assistant attorney general Wendell Berge, who opined that “technological resources” were now joining mineral and geographical ones in measuring the wealth, power, and security of nations. Guiding and applying technology had thus become “a primary

65 Letter, F.C. Jones to Senator H.M. Kilgore, May 3, 1943, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
66 W.J. Donald, Memorandum, “To the voting representatives of member companies in the policies division....” June 3, 1943, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
67 L. A. Hawkins, “Memorandum on Senate Bill, S 702,” February 22, 1943; and Letter, William D. Coolidge to Admiral J.A. Furer, USN, February 27, 1943, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 8, NARA.
concern of Government,” especially if it ensured that the fruits of those advances would cascade
down to all levels of society, not just powerful conglomerations.\(^\text{68}\)

This testimony is an effective illustration of the messy growth of the technoscience ideology
in the United States in this period, and in particular of the ability for its champions to agree on the
growing importance of research while diverging wildly in their core beliefs as to why. In effect,
Kilgore, Berge, and Kaempffert were observing the same symptoms of laggard state-scientific
mobilization that the Tizard Mission had seen three years previously. But unlike the British visitors,
who viewed the problem of the U.S. state in geostrategic and war terms, the New Dealers instead
drew from a 1930s political paradigm to conclude that it had not been complacency or bureaucratic
ineffectiveness, but rather the “monopolistic control of critical sectors of industrial research” that had
had “a paralyzing effect on mobilization of our national strength.”\(^\text{69}\)

The Opening of the Endless Frontier

As the divisiveness of these debates about a government research agency illustrates, U.S.
technoscience—despite having expanded so rapidly and to such dramatic effect—was effectively
rudderless in mass politics in 1944. Technoscience champions themselves could not agree on much of
anything, and debates against those still unconvinced largely looked backwards, rather than to a

\(^{68}\) “Testimony of Hon. Wendell Berge, Assistant Attorney General of the United States, Monopoly and Cartel
Practices, part 6” Hearings of the Subcommittee of the Committee on Military Affairs, U.S. Senate, October 15 and

\(^{69}\) Ibid., p. 714.
coming world in which the United States would play an important hegemonic role. Most alarmingly, it was far from inevitable that the great state R&D expansion rapidly propelling the Allies to victory would itself survive an armistice. After all, following the last war the expanded National Research Council—modest as it was—had been drawn down almost immediately. This time around, the National Association of Manufacturers lobbied to let the private sector, rather than government, make the planning decisions for postwar reconversion. Business leaders hoped to reverse the New Deal and stave off the ossification of “collectivist tendencies” caused by war mobilization. At this fork in the road, a major political push would be needed to prevent a reversal of the gains that had been made since 1940. Decisionmakers at the highest levels would need to wage a public campaign in favor of continuing a major state initiative of science and technology in peacetime. An effective manifesto—so sorely lacking to date—would be needed.

Vannevar Bush had an idea.

As we saw in Chapter 1, Bush had been campaigning for the government to take science more seriously for decades. His OSRD represented a spectacular fruition of those efforts, but it was always intended to be temporary—by edict, it would lapse out of existence six months after the end of hostilities. Moreover, academics, industrialists, and even Bush himself saw the peacetime continuation of the OSRD in its current form as inappropriate and unworkable. With the Kilgore hearings and separate efforts to plan for the postwar by the military and National Academy of Sciences drifting across Washington—all seemingly at crossed purposes—the political situation was

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in disarray. But Bush was ideally placed to propose a solution, as the spider at the middle of the great web of wartime technological advance in the U.S.—the vanguard of the new technoscience philosophers.  

Unlike in 1941, Bush now possessed eminent credibility in the public imagination. The sublime spectacles of atomic weapons, radar, aviation, and the other successes of the war had elevated scientific researchers to a new prominence, and lent political clout to Bush—the brilliant commander, as one journalist put it, of “thousands of eager young scientists who were his personal army—and the army of the future.” Bush had the ear of military leaders, the personal trust of Roosevelt, and good relationships with key academic elites, which made him an ideal ambassador to report to the nation on its needs for the scientific future. Alarmed by the liberal Kilgore proposals, Bush sprang into action. On November 17, 1944, Bush ghost-wrote a letter to himself, which Roosevelt signed as his own, ‘requesting’ a report recommending actions on science, defense, disease, industry, and education. In response, Bush put together four exploratory panels comprised of science leaders and industrialists, many of them culled from his personal circle of relatively conservative science elites. The fruit of their prolonged effort was submitted to Truman on July 5, 1945, in the form of an

“instant smash hit” report, *Science: The Endless Frontier (S:EF).* 74 Two weeks later, Senator Warren Magnuson, under the guidance of Bush, introduced a bill to enact one of the report’s central recommendations: the creation of a new National Research Foundation. 75

Endless words have been written about *Science: The Endless Frontier (S:EF)* by contemporary observers, science policymakers, and historians. Its publication represented a touchstone for thought about the nature of scientific research over the coming decades, and has been noted by scholars as a key watershed moment in American science policy. 76 In essence, the report put forward a series of recommendations and tenets about the nature of science and the state’s relationship to research, among them that scientific progress was the cornerstone of prosperity and security in the modern world; that basic scientific research was the necessary catalyst for practical technological innovation;

75 Mazuzan, “The National Science Foundation,” Chapter 1.
and that government had a duty, interest, and responsibility to support it. It called for a new federal science agency, and an OSRD-style contract system through which fundamental research could be supported in colleges and universities. Finally, it packaged these ideas in an easily-digestible, philosophical form, wrapped around the metaphor of the frontier, which placed science alongside homesteads and clipper ships as a modern version of the “pioneer spirit” which was “still vigorous within this nation.” Science, Bush wrote, “offers a largely unexplored hinterland for the pioneer who has the tools for his task.” The frontier metaphor consciously implicated the government as the caretaker and guarantor of individual expansionist efforts, just as it had been in the age of manifest destiny. The frontier of science, then, was to continue the “American tradition” of a government-backed expansion of the nation’s prosperity. Considering the laissez-faire, philanthropy-driven paradigm of American R&D in the previous decades, this was a radical notion.

The purpose here is not to rehash the details and implications of S:EF—historians have adequately done that many times over. Rather, my point is to draw out Bush’s arguments about R&D as a measure of global power, a formulation that would color the worldviews of the Tizard Generation for years to come. The most striking theme in S:EF is the declaration that American strength and greatness itself would depend on the efficacy with which the nation committed to science. Indeed, Bush made no bones about this point, directly proclaiming that “On the wisdom with which we bring science to bear against the problems of the coming years depends in large

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78 Ibid.
measure our future as a nation.” Of course, coming as it did before the Cold War reoriented discourses on national security, and a month before even the existence of an atomic bomb became public knowledge, the report’s definition of strength centered on a vision of postwar industrial prosperity paired with centralized state readiness for any future OSRD-style ramp-up. Quoting from a joint letter from the Secretaries of War and Navy, Bush defined national security as consisting of three crucial elements: Possession of the latest fruits of science and engineering; a capacity for competitive timeliness in developing them; and the participation of civilians in helping the nation to achieve them.79

The early obsolescence of this pre-Cold War language of national strength did not make the report’s equation of science and technology with the goal of national power any less acute. As Bush wrote, “to achieve these objectives—to secure a high level of employment, to maintain a position of world leadership—the flow of new scientific knowledge must be both continuous and substantial.” Without scientific progress, he noted, “no amount of achievement in other directions can insure [sic] our health, prosperity, and security as a nation in the modern world.” Finally, as R&D became more complex and specialized, it would be “more important than ever that scientists in this country keep continually ahead of developments abroad.”80 One of S:EF’s key accomplishments, then, was to explain and popularize the conjunction of international power with science in the broader political sphere.

79 Ibid.
80 Ibid.
While Bush’s proposal has been characterized as a revolutionary step that codified the lessons of World War II, in reality S:EF was promulgating a vision that dated back decades. In his view, Europeans and Russians had recognized the importance of basic research for centuries; it was only Americans who had habitually failed to understand it. Bush’s was a voice in the wilderness in 1940 when he made the same point; now, sitting atop a war’s worth of technological evidence, his was a megaphone powerfully censuring America’s national complacency. Rather than representing a new philosophy, then, S:EF was instead leveraging the transcendent successes of the war to drive home to a newly alert audience the decades-old contention that the American state and military had been laggard in science and technology.

Bush pulled no punches in arguing this point. In his introduction, he stated bluntly that “we have no national policy for science. The Government has only begun to utilize science in the nation’s welfare.” There were no centralized agencies, he argued, nor congressional committees devoted to science. The glories of “Yankee mechanical ingenuity,” which had become such a point of pride for Americans, were in reality built on European science—a fount now run dry, with the Tizard Mission representing the last droplets from the well. In the U.S., Bush noted, “science has been in the wings. It should be brought to the center of the stage.”81

Of course, in the context of impending victory over the Axis and the furious technological public relations campaign being waged by corporations, Bush’s paradigm would not seem self-evidently convincing—how, after all, could such a technological powerhouse as the United States

81 Ibid.
possibly be impoverished in support for science, as the report claimed? Ever keen to the crucial place
industrial progress held in Americans’ sense of self, Bush argued that attempts to continue relying on
European science would stunt U.S. industry, since “a nation which depends upon others for its new
basic scientific knowledge will be slow in its industrial progress and weak in its competitive position
in world trade, regardless of its mechanical skill.”82 S:EF thus promulgated a counterargument to
industrial assertions that all was well with American technoscience, by noting that without a new
public commitment to basic science, “further progress of industrial development would eventually
stagnate.” It was an appeal to the new, industrial-technological perception of global power then rising
in American minds. The report was, in short, a forward-looking indictment of the U.S. state’s lack of
research mobilization before 1940, appropriating and exploiting concepts and idioms of power that
had arisen since.

It is important to take the contextualization of S:EF one step further. In a word, the text was
influential not because of some genius insight on Bush’s part, but because of the transformative
circumstance of state power ballooning around it. The document, while articulating an ideology of
the scientific process that represented a long-held axiom among many, if not most, prominent
science thinkers of the day, was nevertheless a manifesto made possible by the technological advances
of the war, by the Tizard Mission, and by the dramatic expansion of the U.S. R&D complex. This
expansion, it must be remembered, was only four years old by that point, yet had fundamentally
altered the trajectory of a global total war. S:EF thus became the landmark it did—or, as historian

82 Ibid.
Bruce L.R. Smith put it, “one of the most influential policy documents in the nation’s history”—precisely because it emerged at the end of a victorious techno-war, and because its author had leveraged the discursive power of the state, the British exchange, and the latent capacity of academia and industry in winning that war, to argue his overall point about U.S. power.\(^3\) We can reasonably surmise that the report would have been received as an obscure policy white paper otherwise.

**Technology, Science, and Technoscience**

There is one more critical point to be made about Bush’s report, which is the bluntness with which it played upon Americans’ growing sense of *technology* as power, in spite of the fact that its actual goal was to advocate for the support of abstract *science*. This conflation is important to our retrospective ability to understand the evolution of Americans’ attitudes about technology and national power.

Bush was an interest group lobbyist, dedicated to finding resources for ‘pure’ academic scientists following a war that had represented, in the words of J. Robert Oppenheimer, “a frantic and rather ruthless exploitation of the known; [rather than] the sober, modest attempt to penetrate the unknown.”\(^4\) The aspect of the report that received—and receives—the most attention, therefore, was its identification and popularization of a model of scientific innovation that appealed both to policymakers and the science community itself. This so-called “linear model” of innovation argued

\(^3\) Smith, *American Science Policy since World War II*, 43.

that fundamental scientific research represented the “pacemaker of technological progress.” Basic science—the “free play of free intellects” dictated only by “curiosity for the exploration of the unknown”—served as the direct source of practical applications and invention. Bush’s banking metaphor—that “pure” science was the critical but sacrosanct savings “fund” from which the “capital” for applied science could be “drawn” for national purposes—ensured the preservation of categories that concerned scientists, while providing a conceptual shield that allowed scholars not to be forced by the state to become mere developers of technology. Both freedom of inquiry and the relentless growth of American technological capabilities could be preserved.

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85 Bush, *Science: The Endless Frontier*. Bush, using his talent for reading audiences and turning a tactful phrase, sought to assuage the fears of academics, who feared that a continuation of government interest in science during peacetime would threaten to bring undue control and the corruption of the “purity” of their work, since the state would inevitably pursue immediate technological applications, as it had done in the war.

86 Of course, as scholars like Sheila Jasanoff, Benoit Godin, Radford Byerly, and Roger Pielke have shown, Bush’s conveyor-belt model from science to technology was a drastic oversimplification of both the origins of innovation and the delineation of professional categories in the sciences. Nonetheless, regardless of its veracity, Bush’s linear paradigm did represent a perception and belief shared by many scientific elites of the period. The idea of a stark distinction between applied science and “pure” research was a legacy of ideas arising in the late-nineteenth century’s global science leader, Germany, which had institutionalized the distinctions in its universities and academies. As we have seen, American students flocked to European (and especially German) universities in the first decades of the twentieth century, enabled by the philanthropic exchange programs of the Rockefeller and Carnegie foundations. The crème of the wartime U.S. science establishment—Bush’s contemporaries and OSRD luminaries like James Conant, Isaiah Bowman, and Karl Compton—were drawn from that very Rockefeller generation, and held the S:EF paradigm to be self-evident, even if reality on the ground failed to bear their vision out. Godin notes, moreover, that a more direct domestic antecedent to S:EF existed in the form of a 1928 NRC paper by Maurice Holland that detailed the existence of a “research cycle” from basic science to industrial application. Sheila Jasanoff, “Technologies of Humility: Citizen Participation in Governing Science,” *Minerva* September 2001; Radford Byerly Jr. and Roger Pielke, “The Changing Ecology of United States Science,” *Science* vol. 269, no. 5230; Godin, “The Linear Model of Innovation: Maurice Holland and the Research Cycle,” *Social Science Information* 50:3-4, 2011.

87 Bush, *Science: The Endless Frontier*. 
Bush believed—as did many of his science elite contemporaries—that the “curse of America” was its failure to appreciate pure, prestigious science for its own sake.\footnote{Oral history interview, J. Merton England with Don K. Price, April 18, 1975.} But he knew that American technology, which had delivered an American victory in a global war, would sell. American technology was American power, and it could be discursively leveraged. Thus, although Bush’s true goal was to argue for the importance of a nebulously prestigious ‘pure’ science, he specifically deployed the prospect of a technological payoff, dangling the achievements of penicillin, radio, plastics, and synthetics as a carrot for policymakers and the public. He promised that wars were being won and “millions of pay envelopes” were being filled because of new advancements in high-tech American industry—and that “science made that possible.”\footnote{Bush, \textit{Science: The Endless Frontier}.}

\textit{S:EF} thus both reflected and fed into a broader blurring of the distinctions between science and technology in the American mind in the mid-twentieth century, a point that would be crucial for the debates about the role of the state and the nature of U.S. power in the coming years (and in the coming pages). If \textit{S:EF} represented the ur-text, the foundational scripture for a rising ideology of technoscientific strength, then loyal apostles of the Bush model—and the Tizard Generation in particular—sallied forth in the years after its publication to dutifully explain the importance of ‘pure’ science to the public, usually following Bush in relying on technological might to justify it. As a frustrated Alan Waterman drafted for a \textit{New York Times} piece in 1954, “Americans, who have more automobiles, radios, televisions, refrigerators, airconditioners, telephones, and airplanes than anybody else, may possibly feel, with some justification, that American technology is second to none.”
Complacency in the face of these world-leading comforts, he noted, was understandable, but also dangerous, since Americans not only “take for granted that it will continue in this same satisfactory condition,” but also “tend to lose sight of the fact that many of the fruits of modern technology stem from fundamental discoveries made in other countries, perhaps as long ago as a century.”

Between the lines of this argument we can glimpse what had been the fundamental lesson of the British exchange, which was that the deployment of amazing U.S. technologies perilously hinged on scientific advancements made abroad. But Americans’ sight of this fact remained blurred. It was blurred by industrial campaigns to promote a shallow version of techno-nationalism that tacked a laissez-faire line and downplayed the state channels and scientific origins of recent technological achievements. It was blurred by Bush and his acolytes’ use of technology to justify science, and of their overly neat representations of the research and development process. And it was blurred by their wrestling with how to explain the “linear model,” as well as their torturous deployment of terms like “mobilized,” “applied,” “basic,” “fundamental,” or, as James Conant suggested, “programmatic versus uncommitted” science. As Alan Waterman noted, “a good deal of what is called ‘science’ today is, strictly speaking, not science at all but technology.”


91 As the National Science Foundation’s first annual report boasted, for example, the traditional “time-lag between an important basic finding and its use” had shrunken to near nothing, and in some fields had disappeared altogether. “First Annual Report of the National Science Foundation, 1950-51,” (Washington, D.C.: U.S. GPO, 1951), p. 8.

92 Ibid, p. vi.

This was technoscience. As Carolyn Miller notes, “science” and “technology,” two concepts with vastly different temporal, conceptual, and etymological roots, nevertheless became “entangled with and implicated in each other” in the mid-twentieth-century United States. Historians have long since pivoted to an understanding that the “linear model” of S:EF and its categories of “pure” and “applied” science represented an oversimplification. To scholars today, separating the discourses of Big Science and high technology is usually difficult, sometimes impossible, and often even “immaterial;” instead, the two concepts merge into the broader and more complex discourse of “technoscience.” Following Bruno Latour, scholars have deployed the notion of technoscience—as I do here—as an incorporative concept emphasizing practical and technological outcomes, rather than simply knowledge. As Jennifer Karns Alexander puts it, “at its most basic, ‘technoscience’ makes apparent an interdependent relationship between science and technology, but it can also obviate the very notion of relationship, suggesting a merged or fused new entity.”


95 Carolyn Miller, “Learning from History: World War II and the Culture of History Technology,” Journal of Business and Technical Communication 12:3, July 1998. Miller borrows from the primary exponent of technoscience theory, Bruno Latour. Miller interprets Latour’s conception of notting technoscience as a “network” of facts and artifacts, as well as of people, prior statements, instruments, and natural objects: a network with “resources… concentrated in a few places—the knots and the nodes—which are connected with one another—the links and the mesh: these connections transform the scattered resources into a net that may seem to extend everywhere.” If there is a rhetoric of technology distinct from that of science, these new relationships, and new ways of thinking about such relationships, make it harder to discern.

Indeed, even in the heyday of S:EF and the “linear model,” a fusion between concepts of science and technology was in vogue—and was politically expedient, as onlookers wowed at the “narrowing” of the “gap between research and practical applications.”\(^97\) As Kaempffert put it bluntly, “The plain truth is that there is no difference between pure and applied science. Science is science whether it is engaged in solving the problem of television or of the constitution of matter. Nor is there any difference between the research approach of an industrial and a university laboratory.”\(^98\)

And as one industrialist eyeing the role of science in the demobilizing future noted in 1944, “Research, once associated by laymen with mysterious experiments in scientific laboratories, called by some ‘houses of magic,’ has become a familiar word of common usage.”\(^99\) But whether that research was “basic” or “applied,” public or private, for many Americans—including influential decisionmakers—the distinctions between them were unclear and possibly irrelevant.\(^100\) All that mattered was that the United States was good at it.

The upshot of all of this was that—as we will see—the ideological battle that was waged over the next decade between prewar political paradigms, rising national security paranoias, and newly salient discourses of technoscience, occurred on ambiguous, overlapping, and shifting ground. That the chief exponents of state technoscience-as-national-power were science administrators like Bush, and that the concepts of science and technology were confused and conflated by most, meant that in the civilian, peacetime realm, the field of “science” became the primary theater of ideological war,


even if it was a proxy for technoscience more broadly. This means that we can use debates about national science as a gauge of public and political discourse on national technology.

And the most divisive such struggle was the political fight over the creation of an agency of unprecedented remit in the United States—S:EF’s National Research Foundation, now renamed the National Science Foundation.

*The Closing of the Endless Frontier*

If political discourse on federal technoscience had largely been limited to partisan operatives like Kilgore and those already inside the orbit of wartime R&D before 1945, the release of *Science: The Endless Frontier* heralded an eruption of attention and debate on the subject in the broader public sphere.

Public reception fell along prewar partisan lines about the proper role of government, just as it had for politicians. Pro-state editorials, for example, lauded the “sound reasoning” that would ensure that “the inventive genius that helped to win the war will be geared to the coming peace.” Insofar as a new National Science Foundation would comprise “a sort of scientists’ ROTC,” the future readiness of the U.S. for war could be assured. Another newspaper begged for the passage of any science bill, so that it could finally “elevate the United States to a proper place in the sun of scientific research.”

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Others were more skeptical. The *New York Sun* conceded that “support of research for national defense is clearly a matter for public enterprise. It is less clear what advantages would flow from an arrangement to revive public support of private research.” Conservative science journalists suggested that Pasteur, Einstein, and Rutherford had derived their successes from individual genius, not government backing. The *Wall Street Journal* censured the “Papa-knows-best philosophy” behind the statism of Kilgore and his allies, noting that to “substitute collective for individual initiative in the field of research… would be fatal to the free enterprise system.”

No matter the reaction or the political leaning, as regards the public’s interest in the new direction of federal science, two things are clear. One is an acceptance of the validity of Bush’s critique of the United States’s prewar laggardness. Commentators from both ends of the political spectrum noted with concern the manner with which the U.S. had had to scramble its scientific resources at the time of Pearl Harbor. S:EF seemed to convince many that “scientifically we were woefully unprepared” for the war. As iconoclastic columnist Drew Pearson wrote, the nation had been saved from fascism only by the “hurriedly organized group of patriotic scientists gathered under Dr. Vannevar Bush.”

Pervasive language of “finally” rising to global status, and joining European science powers “for the first time,” clearly shows absorption of Bush’s message. Remarkably, some observers were so convinced of Bush’s argument that they worried that the nation was still behind. As

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102 Commentary on *Wall Street Journal* and *West Virginia Intelligencer* editorials, July 28, 1945, RG307, 4 - NSF Historian file, entry UP-UP-1; RG307-Stack 103-Row 37-Cpt 15, box 44, NARA.
*Fortune* magazine fretted in September 1946, U.S. development appeared to be “lagging more or less everywhere.”\(^{105}\)

The other fact shining through the public’s reaction was the equation of science and technology with the maintenance of American global power. A collection of congressional interviews with small business owners nationwide, for example, found a pervasive feeling that a “central research agency should be organized, established, and provided with the necessary research facilities to make it the best possible organization in the world and far superior to that of any foreign power.” One owner from North Carolina urged that “we must lead the world in research both for the general health of the people, health to business in general, and to keep our military up to date and ready for any emergency.” Another stressed that it was “imperative that United States establish and maintain a substantial world leadership over other nations in all phases of industrial and military research.”\(^{106}\) The *Charlotte News* thus seemed to echo prevailing sentiment when it stressed that an NSF would “give impetus to research and, for the first time, proclaim as national policy that our future as a nation is inseparably linked with our eminence scientifically.”\(^{107}\)

It must be highlighted that many laypeople were taking their first real look at science during this period, and relied for guidance on the testimonies of those considered to be eminent


representatives of the craft, like Bush and Oppenheimer. The power and simplicity of S:EF’s conveyor-belt model of how innovation worked, and its vision of the critical national importance of science and technology, thus came to be taken as read by policymakers and the lay public alike. As a result, political debates moved past the seemingly axiomatic technical aspects of R&D, and instead moved on to traditional ones about the proper role of government in fostering it.

Thus, in the sense of publicizing America’s scientific laggardness, Bush’s mission with S:EF was accomplished. But in activating his tenets about fostering scientific innovation in an independent, civilian bureaucratic-political paradigm, S:EF was to prove a failure. Furious political battles for the next half-decade, still perched over the political faultlines of the New Deal, torpedoed an early and effective implementation of civilian state science in the United States. Ironically, too, Bush’s rising stature on the Hill, and the rise of his ‘character’ as a scientific administrator in public and in Congress, triggered a furious backlash from politicians and scientists with opposing political views. The result was gridlock, with no clear path forward for American state R&D. The debates, however, also illustrate the growing importance of global power to U.S. policymakers, and their attempts to understand technoscience’s role in it.

The discussion surrounding S:EF turned up the heat on Congress to decide what responsibility the public coffers should have in American research. As Senator Magnuson introduced his Bush-influenced bill, a furious Harley Kilgore brought out yet another leftist counterproposal. The divides between the two were immediately apparent and instantly partisan along predictable,

traditional lines about the scope of government activity—how politically accountable should the foundation be? Who would get the patents if it funded private research? Finally, the two sides split over the inclusion of social science in the scope of the new foundation, with liberals eager to deepen government’s commitment to rational social study (as had begun with the New Deal’s short lived Science Advisory Board), and conservatives fundamentally opposed.109

In September 1945, President Truman broadly endorsed Kilgore’s proposals. In his message to Congress, he specifically appealed to America’s new global role, noting that “No nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports and encourages the work of science in university, industry, and in its own laboratories.”110 Truman had been the one to shield the Manhattan Project from the skepticism of traditionalist military ordnance chiefs; his chief of staff had begged that the OSRD not be shuttered; and now the president was putting the weight of the White House pulpit behind the creation of a robust federal research foundation. For perhaps the first time, a committed technoscience champion—albeit a part-time one—occupied the Oval Office.111

111 Truman resisted pressure from, among others, the Chief of Naval Ordnance to put an end to the billions of dollars in expenditure for an untested secret bomb, and was visibly buoyant towards the same officers when he found out that the Trinity test had been successful while he attended the Potsdam conference. Interview of Dr. Carroll V. Newsom by J.M. England, April 27, 1976, RG307, 4 - NSF Historian file, entry UP-UP-1, stack 103, row 37, cpt 15, container 44, NARA.
Through April 1946, the two bills were debated in a series of joint hearings, but as distance from the war and from S:EF increased, Congress settled further into reverse salience. That there was little political will pushing the bill forward is evidenced by the fact that it was not subjected to a floor vote until July.\textsuperscript{112} As the Washington Post’s Marquis Childs wrote exasperatedly, “the farther we get from the war, the more we are inclined to forget the lessons the war. In so many ways, we seem to be lapsing back into the past or, rather, into a convenient dream of the past.” Childs noted the near-consensus after VJ Day that science and technology were central to the nation’s well-being, and wondered aloud why the nation seemed to squander that very resolve in favor of traditional political squabbles. “It begins to look,” he noted somberly, “as though only in war we can unite in a common cause.”\textsuperscript{113}

The lack of action opened the way for other lawmakers to table yet more science legislation, adhering even more strictly to ideological orthodoxy. Senator Raymond Willis of Indiana produced a bill that proposed essentially annulling S:EF and replacing it with a counter-report by the conservative National Academy of Sciences. Willis’s bill failed by a slim margin.\textsuperscript{114} Frustrated by Senate counterproductivity, meanwhile, the influential House representative Wilbur Mills introduced his own proposal. Mills doubled down on S:EF and its arguments on laggardness, opining that the war had taught Americans that they must “remain strong in every way,” and that “clearly one essential factor in our future security is a condition of vigorous and healthy scientific progress.” S:EF,

\textsuperscript{114} Parsons, “National Science Legislation.”
he added, had revealed that a new impetus was needed for basic science, and “such new impetus can come promptly only from the Government.”\footnote{“Statement of Hon. Wilbur D. Mills,” National Science Foundation Act, Hearings, Subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, May 1946 (Washington, D.C.: U.S. GPO, 1946).}

Partisan squabbles persisted into the next Congress, which followed the Republican sweep of the 1946 midterm elections. Kilgore was divested of his Science Committee chairmanship and replaced by the Republican H. Alexander Smith, who endeavored to remove government oversight of the proposed foundation, likely with the tacit support of Bush.\footnote{Kleinman, \textit{Politics on the Endless Frontier}, 125.} The resultant bill eliminated social science, and tilted heavily toward promoting military applications. In an indulgence to conservative Republicans and Southern Democrats, it also demanded minimal spending (earmarked for scholarships), with the bulk of the money to be merely transferred from the closure of the OSRD. Magnuson and Mills joined Smith’s effort, and it passed both houses.\footnote{Memorandum, John H. Teeter, “National Science Foundation Legislation,” January 15, 1947, box 87, Vannevar Bush papers, LoC.} On August 6, an incensed Truman vetoed the bill, citing its “marked departure from sound principles for administration,” since it vested enormous power and funds in the hands of unaccountable private citizens. Importantly, Truman also noted that “under present world conditions,” the government’s science activities had become “vital to our national welfare and security,” and that the conservative NSF bill—with its byzantine and unaccountable administration—would jeopardize those activities at a crucial time in the nation’s history.\footnote{Harry Truman, “Memorandum of Disapproval,” August 6, 1947, box 87, Vannevar Bush papers, LoC.}
Despite his protestations over specifics, Truman’s veto was part and parcel of a larger political battle along standard partisan lines. The president’s trusted advisers on scientific matters were mostly ardent New Dealers. As William Blanpied has argued, Budget Bureau luminaries like director Harold Smith, Elmer Staats, Don K. Price, and William Carey cut their teeth in the Depression years as protégés of the Progressive economist Charles Merriam. Their clout in the Oval Office, and their suspected influence in the NSF veto, only further incensed the right. H. Alexander Smith howled that the president was making “a political football” out of “this new and untried experiment in Government-supported research… unique in our history,” which would be “the greatest contribution made to this country by any Congress since the turn of the century.” The “cause of science,” he said, had been set back ten years at the stroke of a pen. But the administration was focused on other things than the cause of science. Truman was jockeying for political ground against powerful Republicans in a pitched battle over the postwar growth of executive power and global engagement. A federal science foundation was simply one more casualty of those political frictions.

In 1948, the Senate again passed a bill, but the House failed to bring its version out of committee, and—exacerbated by a presidential election around the corner, a showdown over the proposed Marshall Plan, and an impending political fight on the Federal Reserve and inflation rates—

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120 Statement, Senator H. Alexander Smith, N.J., August 6, 1947, box 87, Vannevar Bush papers, LoC.

Congress adjourned without taking any action.\textsuperscript{122} It was now three years since the end of the war, and eight years since the Tizard Mission, and a centralized, permanent civilian research agency had yet to materialize.

Ultimately, even S:EF became the subject of partisan rancor, as liberals refused to allow it—and the conservative Bush—to remain the only philosophical touchstone for federal science ideology on Capitol Hill. Truman put his close adviser John Steelman in charge of preparing an S:EF-style report more reflective of liberal political priorities. The result, a five-volume opus called “Science and Public Policy” (the Steelman Report), was released in August 1947.

This report was unprecedented in its scope—never before had there been such a comprehensive survey of both government and non-government research activities. While S:EF had been the work of the scientific community and private interests, the Steelman Report was firmly an executive branch document.\textsuperscript{123} As a New Deal-inflected counterpunch to Bush’s program, the Steelman Report carried a commitment to government planning as the only effective way to mobilize science for the national interest.\textsuperscript{124} As Don K. Price later remembered, the report was an active initiative among Truman’s left-leaning circle to create a “broader gauge policy than the war-time leadership would go for.” The conservative science leadership represented by Bush, they believed, was


actually holding back the national interest.\textsuperscript{125} Accordingly, the Steelman counterproposal called for a robust civil service for science, better government salaries, and a plan for federal research funding to reach $50 million in two years, and $250 million by 1957.\textsuperscript{126}

Most importantly, the report was explicitly geopolitical. The global landscape had changed since the interwar period, as had America’s place in it, and technology and industry were becoming indispensable to foreign relations. Steelman anticipated the rise of state-driven international competition in technology “of a sort we have not hitherto had to meet.” To stay ahead of rivals abroad, Steelman proposed that scientific reconstruction be made an integral part of the proposed Marshall Plan, a scheme in which the U.S. would help rebuild broken technological economies in exchange for those countries being “willing to enter whole-heartedly into cooperation with us.”\textsuperscript{127}

To establishment liberals in the Truman administration, then, science represented a newfound potential solution to the country’s increasingly complex strategic requirements abroad. As the Budget Bureau’s William Carey recalled, “You have to think of the atmosphere. This was postwar, most of the world in ashes, the US riding very, very high, dreaming great dreams—the Full Employment Act, the United Nations, the Marshall Plan. And then, along in parallel, there was to be

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\item [\textsuperscript{125}] Oral history interview, Milton Lomask with Don K. Price, January 18, 1973, RG307, 4 - NSF Historian file, entry UP-UP-1, stack 103, row 37, cpt 15, container 44, NARA.
\item [\textsuperscript{127}] Steelman, “Science and Public Policy,” p. 5. For more on the U.S. role in scientific reconstruction in Europe, see Camprubí, Roqué, Sáez de Adana, eds., De la Guerra Fría al Calentamiento Global: Estados Unidos, España y el Nuevo Orden Científico Mundial (Madrid: Libros Catarata, 2018); and John Krige, American Hegemony and the Postwar Reconstruction of Science in Europe (Cambridge, Mass.: MIT Press, 2008).
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a new age of science and creativity. . . We were building a brave new world and all would go well. There was a very short window of idealism and optimism.”

As reports and counter-reports flew across Washington, public figures pleaded with politicians to keep the global gravity of the issue in mind. The New York Times’s Kaempffert fretted “that Soviet Russia has approached this task more realistically than have Dr. Bush’s committees.” A year later, the eminent war journalist Raymond Swing dedicated a full broadcast to the government’s failure to foster a civilian state-science apparatus, something that meant “the United States was left a lap behind its proper place in the race for scientific advance.” Warning of an overconcentration of scientific knowledge among large corporations and in the military, Swing told his ABC listeners that “it will not do to say that the socialization of discoveries made by spending public money is socialism and hence not the American way… Scientific research can no longer be carried forward on the narrow scope of prewar years.”

But the narcissism of small objections continued nevertheless. After the 1948 elections rebuked the “Do-Nothing Congress” and swept Democrats back to power in both chambers, a fatigued Senate passed yet another NSF bill with almost no interest or discussion. It went to the lower chamber, where it shriveled on the vine as the House Rules Committee insisted that, even if a science

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130 “Raymond Swing’s Broadcast,” American Broadcasting Co., September 13, 1946, box 27, Vannevar Bush papers, LoC.
131 Ibid.
foundation were approved, not a single further taxpayer dollar go to science.\textsuperscript{132} Over the next year, the legislation was further derailed by controversies over the increasing presence of the FBI and security provisions in the science proposals.\textsuperscript{133} Only in March 1950, through parliamentary maneuvering, did pro-science politicians manage to extract a cobbled-together bill from the committee quicksands. On May 10, Truman signed Public Law 507, the National Science Foundation Act of 1950. Alan T. Waterman, deputy chief of the Office of Naval Research, was named its director. The Act had taken the better part of a decade, and more than 1,200 pages of testimony from 150 experts.\textsuperscript{134}

As political scholar Don K. Price wrote in 1953, “In theory, a member of Congress could agree that basic research was a good thing for its own sake. But this was not the kind of belief that led a member to stand up and be counted in favor of the spending of federal funds.” As a result, he noted, “there was no great political steam behind the National Science Foundation.”\textsuperscript{135} This lack of “steam” cast a pall over the new agency, and would continue to do so for nearly another decade.

Given the intensely partisan debates that occurred in the first years after the war, it would be tempting to interpret congressional inaction as merely grandstanding politicians using science as an

\textsuperscript{132} Using the House Rules Committee as legislative quicksand for legislation they didn’t like was a common tactic for Congressional conservatives through the 1940s and 50s, notably including its use to quash civil rights legislation. “History of the Committee on Rules,” (Washington, D.C.: U.S. House of Representatives, 2008), digitized, http://rules.house.gov/110/comm_history.html

\textsuperscript{133} Oral history, England with Brown, August 1, 1975.

\textsuperscript{134} “Appendix II: Legislative History of the National Science Foundation Act of 1950,” box 173, Vannevar Bush papers, box 173.

\textsuperscript{135} Price, “The Organization of Support,” p. 30.
ideological bludgeon. In reality, however, the end of World War II marked the first time scientists themselves became intensely political *en masse*, transforming their interests into a powerful—but divided—lobby. Historians have, of course, produced an enormous volume of excellent scholarship on the politicization of scientists. For our purposes, it is useful to highlight a few key factors. The first is that the ideology of technoscience as American power was a key factor in emboldening scientists to take open part in the public square. Divisive as science and technology may have been, there was now at least enough general recognition—and fear—of the power emerging from the nation’s laboratories that scientists now expected to be listened to. Also noteworthy is that, amid all the raucous debates about militarization, civilian control of new technologies like the bomb, and the dilemma of funding versus control, scientists often broke roughly along similar lines to politicians on the Hill—an internecine split, that is, between Hoover-era conservatives and New Deal-era progressive leftists.

By the late 1940s, however, external circumstances were beginning to overshadow calls by scientists of all stripes for a civilian research foundation, and many of the arguments that science lobbyists had placed at the center of their advocacy began to ring hollow. For one thing, a good portion of scientists’ early arguments for state support had been based on the notion that research would be crucial for the nation’s economic future. Bush dedicated considerable space in *S:EF* to the notion that “more and better scientific research is one essential to the achievement of our goal of full

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employment.” But the period after the end of the war ushered in an era of huge gains in national prosperity—34 consecutive months of economic expansion, a rate of annual GDP growth of nearly six percent, and an increase in employment of nearly 18 percent. The boom weakened science groups’ arguments that the well of European research running dry would cause undue harm to American industry. Meanwhile, the strikes and labor issues of 1946-47 added a further, more immediate complication to the discussion of how to foster industrial well-being.

More pertinently, the deteriorating international situation and increasing security paranoia took its toll on the state-science debate, as the twin impulses of anticommunism and military preparedness began to take precedence over domestic concerns. Privately, scientists groused that researchers were becoming dissociated from national security in the public eye, just as they had been before the war. James Conant complained that the Medal of Merit was issued only to the major players in the atomic bomb project, while key professors and scientists from other fields remained anonymous. More gloomily, the Rockefeller Foundation’s Warren Weaver fretted that the nation pinned medals on “somebody who wrote a good cook book for the armed services,” while neglecting recognition for scientists altogether. If the science lobby’s aim after the war, he wrote, had been to

137 Bush, *Science: The Endless Frontier*.
140 Letter, James Conant to Vannevar Bush, May 24, 1946, box 27, Vannevar Bush papers, LoC.
promote “the necessity for treating scientists like human beings, and recognizing their roles in national defense,” then “the record here in this connection is not good.”141

These changing circumstances led technoscience advocates to exploit the rhetoric of security more directly. In a hearing before the House in 1946, Johns Hopkins president Isaiah Bowman chided Congress for sitting on their hands when a National Science Foundation represented such a crucial factor in the arena of national defense. In a forceful diatribe, Bowman recalled the ways that new technologies in strategic bombing had enabled American forces in Japan to focus “upon one vital spot after another and wipe them off the map.” The harsh reality of the postwar world, he noted, was that “we do not yet have peace or even the promise of it.” Failure to inaugurate an NSF would be “folly” in the face of the darkening international situation. “Daily we read of arriving international difficulties,” Bowman scolded, so “why should we not daily read that Congress is alert to the dangers that surround us, and is doing something specific about it?” The singular truth that the scientists of America desired to impart, he concluded, was that “the formation of a national science foundation is basic to national security.” The bureaucratic and organizational details would be sorted out at some point, but defense required immediate action.142

By the end of the decade, Bowman’s rhetoric came to represent a common strategy among the Tizard Generation. For example, the 1949 annual message of NACA—ostensibly a civilian agency—served mostly as a plea to Congress from its chief, Jerome Hunsaker, that in state technology

141 Letter, Warren Weaver to Vannevar Bush, January 24, 1947, box 117, Vannevar Bush papers, LoC.
“there is no excuse for a complacent attitude. We need to maintain our technological superiority… to afford a reasonable degree of security consistent with the national economy.”\textsuperscript{143} A year later, the National Research Council produced a series of recommendations for the Navy—endorsed by such bodies as the American Chemical Society, American Institute of Physics, and the Engineers’ Joint Council—on how to mobilize scientists for war, with an eye to “maintain[ing] our scientific leadership” in the face of the Soviet Union’s numerical superiority.\textsuperscript{144} And MIT’s Karl Compton—one of the driving forces behind the ramp-up of the Radiation Laboratory and NDRC—fretted that conflicts of interest and wishful thinking had induced an “over-precipitate demobilization after World War II,” which now made the United States “slow to accept the reality of the mounting program of Russian aggression.”\textsuperscript{145}

Chapter 5 will explore the relationship of defense and technoscience more fully, but it suffices to say here that by 1950 the original arguments for an NSF dedicated innocently to prosperity, employment, and “full wallets” had become a distant memory.

\textsuperscript{143} Jerome C. Hunsaker, “Thirty-Fifth Annual Report of the National Advisory Committee for Aeronautics,” November 17, 1949, box 82, Vannevar Bush papers, LoC.
\textsuperscript{144} Letter, M.H. Trytten to Alan Waterman, October 20, 1950, box 23, Alan Waterman papers, LoC. For more on the ‘booms and busts’ of support for science and technology as the nation oscillated between war and peace in the early Cold War, see David Kaiser, “Cold War Requisitions, Scientific Manpower, and the Production of American Physicists after World War II,” \textit{Historical Studies in the Physical and Biological Sciences}, vol. 33, no. 1 (2002), pp. 131-159.
\textsuperscript{145} Address, Karl T. Compton, “Engineers and National Security,” Hoover Medal ceremony, American Institute of Electrical Engineers, 1950, box 26, Vannevar Bush papers, LoC.
“As piddling as a government agency can be”

The extended skepticism and debates that had dogged the creation of the NSF had a direct bearing on its first decade of operations. While S:EF had called for the foundation to be a robust, centralized agency for all federal science activities, by the time the NSF opened its doors in 1951 it was circumscribed, obscure, and starved of resources. The moment for the creation of a strong civilian hub to launch the nation into a future of global technoscientific leadership was long past.

There was a hard ceiling on the ambitions of civilian R&D advocates from the very first day. To begin with, in finally passing an NSF Act, Congress took the very unusual step of imposing a strict appropriations limit on the new agency. Politics and recession catalyzed a renewed push for economy in Washington in 1949, and one of the compromises to allow the foundation to exist at all was the imposition of a $15 million limit on its spending. This relatively low ceiling turned out to be moot anyway, as administrators of the nascent agency could scarcely dream of being given $15 million during their first half-decade, no matter how hard they lobbied. When in the midst of the Korean War the agency presented its first budget proposal—an economical sum of $14 million—the House appropriations committee slashed it ninety-eight percent, to $300,000, stating flatly that an NSF’s “early aid in the present emergency is not very tangible.” In a direct rebuke of scientists’ arguments about the necessity of basic science, House members provided just enough, as one journalist noted at the time, for a skeleton crew of 30 staff to “go back and think up something else.” Waterman’s

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147 Statement, Alan T. Waterman, National Science Foundation, August 19, 1951. Vannevar Bush papers, box 117, LoC.
attempts on Capitol Hill to explain S:EF’s conveyor-belt model and to invoke the successes of Faraday, Hertz, Marconi, Thompson, Koch, and Pasteur, all fell on deaf ears—none of those scientists, bluntly noted representative John Phillips of California, was subsidized by government.\footnote{148 “The Science of Appropriating,” \textit{Washington Star}, August 21, 1951.}

Public outcry to this indifference came quickly. The \textit{Washington Post} wrote that “For America it’s the ‘Believe It or Not’ Congressional error of a generation, and a wind-fall victory for Stalin and his mob.”\footnote{149 “Body Without Substance,” \textit{Chemical \& Engineering News}, August 27, 1951.} The American Council on Education sent out an emergency supplement to its journal calling on educators nationwide to protest this “dangerous” wrong directly to the Senate.\footnote{150 “Emergency Supplement: House Refuses Funds for National Science Foundation Program,” \textit{Higher Education and National Affairs}, August 23, 1951.} And a desperate Waterman culled together endorsements from outside groups as eclectic as Standard Oil, the Atomic Energy Commission, the Association of Land-Grant Colleges and Universities, the Office of Defense Mobilization, and the conservative National Association of Manufacturers, to stress the consensus that science was “fundamental to our progress and our survival as a nation.”\footnote{151 Statement, Alan T. Waterman for Committee on Appropriations, United States Senate, September 19, 1951, box 24, Alan Waterman papers, LoC.} Ultimately the Senate and House agreed to restore one quarter of the requested funds. The NSF’s first year of grantmaking thus stood on a budget of just $3.5 million, leading Waterman to “hope that industry will find it possible to augment these efforts with substantial support of similar kind.”\footnote{152 Speech, Alan Waterman, “Horizons in Industrial Science from the Viewpoint of Government,” AAAS, Philadelphia, Penn., December 29, 1951, box 44, Alan Waterman papers, LoC.}

Fiscal problems were not limited only to the foundation’s first year. An annual cycle of dramatic budget cuts followed by pleas for restoration continued for most of the decade. As

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\textsuperscript{151} Statement, Alan T. Waterman for Committee on Appropriations, United States Senate, September 19, 1951, box 24, Alan Waterman papers, LoC.
\textsuperscript{152} Speech, Alan Waterman, “Horizons in Industrial Science from the Viewpoint of Government,” AAAS, Philadelphia, Penn., December 29, 1951, box 44, Alan Waterman papers, LoC.
Waterman looked at the storm clouds ahead for 1953’s budget, he enlisted the Department of Defense to endorse the NSF in the hopes that military cachet could convince hawkish lawmakers of the importance of science. The House still cut Truman’s $15 million NSF request to just $3.5 million. In the 1953 fight over the 1954 request, the House again slashed the foundation’s budget, and Waterman again begged for restoration, this time making a case that the NSF could help to fight the conservative bugbears of duplication and redundancy in federal activity—a function that, remarkably, many in Congress believed to be the only purpose of the foundation. And so the pattern went.

The starvation of the NSF did not occur in a vacuum. In fact, it was part of a scheme on the part of some Congressional budget hawks to axe ‘extraneous’ federal technoscience wherever they could. One ruse was to use the NSF itself as a backdoor way to cut science funding across the federal apparatus. In 1951, Truman and the Bureau of the Budget reduced the military’s basic research funding by $5 million, and raised the NSF’s request by the same amount, in order to enact a planned, mutually-agreed transferal of Defense Department research programs to the civilian agency. Congress was delighted at the $5 million reduction in the defense budget, but swiftly slashed the $5 million out of the NSF budget as well, with the result that the science programs themselves were smothered.

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153 Diary note, “Conference with Dr. Walter Whitman, Chairman, RDB,” January 29, 1952, box 1, Alan Waterman papers, LoC.
154 Statement, Alan Waterman for Subcommittee on Independent Offices, Senate Appropriations Committee, April 24, 1953, box 87, Vannevar Bush papers, LoC.
155 Price, “Organization of Support,” p. 34.
Two years later the Senate made another such move. In 1953, legislation was written to abolish the unusual $15 million appropriations cap on the NSF, with the stated purpose of enabling the foundation to better absorb other agencies’ research programs. The removal of the limitation for the NSF was lauded, but sure enough, the following year Congress decreased other agencies’ science budgets by nearly the same amount as it increased that of the NSF, resulting in disruption and stagnation. As Price later recalled, the failure of civilian science to gain a toehold in the American political sphere stemmed from the fact power derived from “your relations with appropriations subcommittees and specialized legislative committees, and the Science Foundation in those terms just wasn’t in there with the military department and the National Institutes of Health and the Atomic Energy Commission.”

Administrators noted with desperation the chilling effect this lack of support was having on research itself. While S:EF had advocated from the beginning the critical need for a “stability of funds so that long-range programs may be undertaken,” by the mid-1950s such continuity was proving exceedingly difficult. An NSF report in 1954 concluded that “present legislative actions on appropriations do not encourage or permit long-range commitments.” Moreover, those established

157 Address, Lee A. DuBridge, “Science Serving the Nation,” Johns Hopkins University, October 16, 1954, box 184, Vannevar Bush papers, LoC.
159 Bush, Science: The Endless Frontier.
agencies that did try to provide stability for science programs were forced to do so by tying up their available funds in existing projects, impeding the pursuit of new programs.\footnote{160 “Continuity of Support,” Advisory Committee on Government-University Relations,” December 10, 1954, box 85, Vannevar Bush papers, LoC.


162 Zuoyue Wang, \textit{In Sputnik’s Shadow: The President’s Science Advisory Committee and Cold War America} (Piscataway, N.J.: Rutgers University Press, 2009). 43. Note that “on tap but not on top” is a quote originally attributed to Winston Churchill.

163 Wang, \textit{In Sputnik’s Shadow}, p 44.

164 Oral history, Lomask with Carey, January 22, 1973.}

Nor could the struggling agency turn to the White House for support. Although new president Eisenhower made occasional statements extolling scientists’ “vital role in our Nation’s security and growth,” he also harbored a deep reluctance to elevate scientists into policymaking circles.\footnote{161 As Zuoyue Wang has illustrated, Eisenhower’s cabinet exhibited a “profound ambivalence” towards science, as exemplified by national security adviser Robert Cutler’s philosophy that scientists should be “on tap but not on top” in the national political framework.\footnote{162 Trust between the science community and Eisenhower soured further when the President sided with McCarthyites in the security hearings of Robert Oppenheimer.\footnote{163 Relations between the White House and the science community, as Carey remembered, were therefore “very, very low” for most of the 1950s. At one point, Carey himself begged the administration “to demonstrate its support for science, to say something positive since we had been hearing nothing but negative things.”\footnote{164 Eisenhower’s sympathy for the NSF also strained when the agency failed to fulfill conservatives’ principal vision for it: the elimination of federal duplication and waste. The}}}

relations, as exemplified by national security adviser Robert Cutler’s philosophy that scientists should be “on tap but not on top” in the national political framework.\footnote{162} Trust between the science community and Eisenhower soured further when the President sided with McCarthyites in the security hearings of Robert Oppenheimer.\footnote{163} Relations between the White House and the science community, as Carey remembered, were therefore “very, very low” for most of the 1950s. At one point, Carey himself begged the administration “to demonstrate its support for science, to say something positive since we had been hearing nothing but negative things.”\footnote{164}

Eisenhower’s sympathy for the NSF also strained when the agency failed to fulfill conservatives’ principal vision for it: the elimination of federal duplication and waste. The
Foundation, of course, was singularly incapable of and unprepared for such a role, lacking as it was in resources, power, and clout. Carey noted that the administration “used every stratagem that we could think of to needle the NSF into exercising this evaluation function,” but Waterman dug in, saying it was asking too much of his “small, semi-invisible” agency, and that perhaps one day if the foundation and its basic scientific remit could attain some respect among people in power, “then we’ll be grown up and perhaps we can do some of those things.” The overall result was an intractable disconnect between the White House and American science, especially compared to the warm relationship that had been forged under Roosevelt and Truman. As Eisenhower advisor Eugene Skolnikoff noted, Alan Waterman “essentially never saw the President. He had almost nothing to do with the political process.” Thus, when the House of Representatives repeatedly set upon to the NSF’s reasonably generous White House appropriation requests with its budget scythe, the bully pulpit remained silent, and it fell to the weak and fledgling agency to campaign to Congress and other government bodies itself.

Waterman recognized the direness of this position from the outset. In a speech detailing the first months of the agency’s operation, he noted that “in spite of the significant roles that science and technology have played in the first half of this century, they have gone singularly unrecognized in the

To regain a general sense of the importance of technoscience, he and his administrators were obliged to pull every rhetorical lever they could muster in order to justify not only the agency’s existence, but also the importance of basic science to national strength. As National Science Board member John T. Wilson remembered later, board members hit upon solar energy and agricultural advancements as concepts that could be used to talk about basic science in terms that politicians could grasp. They did so doggedly, to the point that they were rebuked by one congressman who was “tired of hearing about seed corn.” In Wilson’s words, “Rust-free wheat and hybrid corn. My God, we dragged those out interminably.”

Another strategy was to raise the specter of national decline due to scientific backwardness, particularly in relation to the Soviet Union. As we have seen, esteemed American scientists had long decried the public’s lack of respect for science compared to Europeans. In 1953, for example, Robert Oppenheimer opined that “I am over and over again appalled by how ignorant, how incredibly ignorant of the most rudimentary things about my subject are my fellows the historians, my acquaintances the statesmen, my friends the men of affairs.” The NSF’s leadership thus brainstormed ways to frame science in terms of a global power imbalance. As the NSF’s governing board tried to argue to the Bureau of the Budget, “Russian’s manpower is a threat which can be countered only by the most effective use of science and technology.” If Russia was doubling down on

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167 Remarks, Alan T. Waterman, “The Beginnings of the National Science Foundation,” National Association of State Universities, Edgewater Beach Hotel, Chicago, Ill., April 30, 1951, box 43, Alan Waterman papers, LoC.
its scientific commitments, then research grants and education were absolutely indispensable to the international position of the United States.\textsuperscript{170}

These efforts bore little fruit, however. In 1954, after three full years of such lobbying, Caltech president Lee DuBridge railed against the “shameful neglect” with which those on Capitol Hill still treated the NSF, noting that the idea that there somehow existed a raft of excess and waste in American science represented “one of the most tragically mistaken delusions of recent years.”\textsuperscript{171} \textit{Scientific American}, meanwhile, reported that the NSF seemed doomed to remain “about as piddling as a government agency can be—for all its great importance to the future of the nation.” Barely alive after being “nearly killed in the womb,” still operating out of makeshift offices in Washington’s former Cosmos Club, and continuing to receive only “grudging and spartan support,” the NSF seemed ordained to fail in its mission to ensure the future technological prosperity of the nation.\textsuperscript{172}

And the problem was not just Congress. In the mid-1950s, NSF staff traveling to university campuses and professional meetings regularly found that academics and scientists they talked to—and especially younger ones—had never heard of the foundation at all, or else confused it with the National Academy of Sciences.\textsuperscript{173} And despite \textit{S:EF} having laid out the case for science as a direct economic engine a decade previously, during the recession of 1954 Waterman received an entreaty

\textsuperscript{170} Memorandum, Neil Carothers for Alan Waterman, “Confidential: Budget Appeal,” December 1, 1953, RG307, 4 - NSF Historian file, entry UP-UP-1; RG307-Stack 103-Row 37-Cpt 15, container 21, NARA.


from Neil Jacoby of the Council of Economic Advisers wondering if the NSF might elucidate any
“bearing of scientific developments” that might relate to the “growth process” of the national
economy.174

Ironically, then, just as American science luminaries in the 1920s had looked longingly
overseas to cultures they deemed to be more enlightened toward research, so here they remained
doing so, decades later, in the midst of the ostensible “atomic age,” when Americans had supposedly
learned from the awesome sublimility of the war to appreciate technological progress. As Waterman
lamented in 1954, “the United States has not achieved the tradition of respect for learning in all fields
that is so much a part of the culture of many other peoples.” Wistfully, he recalled how Louis Pasteur
“was escorted into the Sorbonne by the President of France;” how the royal Honours List in Britain
was littered with knighthoods for researchers; and how Soviet students were presented every
incentive to go into R&D careers. He even noted that on a recent visit to a symposium in Japan, “in
that economically depressed country a part of the administrative expenses of the conference had been
met through the subscriptions of school children.” All while in the U.S. a lack of appreciation, an
atmosphere of security restrictions, and systemic failures conspired to sap the potential
technoscientific strength of the nation.175

A greying Bush, speaking four years later, expressed the matter even more forcefully. Since
the war, he argued, the United States had been swallowed by “a wave of anti-intellectualism,”

papers, box 1, LoC.
exemplified best by “the invention of the term ‘egghead’ as a label of opprobrium.” It was a circumstance, he said, that was “not only injurious to the public welfare” but also “positively dangerous.” While the fright of atomic bombs perhaps contributed to “a revulsion, sometimes unconscious, from a complex existence,” Bush felt the complacency of comfort was more to blame. America now had glorious new medicines to eradicate disease, “the availability to the great majority of the population of gadgetry—automobiles, washing machines, television,” and unprecedented free time and prosperity. But even as the country faced “another great power armed to the teeth with modern weapons,” many Americans were content “to live partly in a dream world, where there are no threats, and no crises… They turn against those individuals and those ideas which exemplify the inherent nature of the struggle we face.” They turned against, that is, the purveyors of science and technology.176

Conclusion

While American politicians, administrators, educators, and the public clashed internally about the role of science and technology in their society, the importance of state R&D to geopolitics only became further entrenched. By 1955, it was clear that the Soviet Union was doubling down on its training of scientists and engineers. When Western pro-technoscience advocates spoke on this matter, they usually did so in existential terms. The worry was not merely about a particular facet of a

rival’s strength, nor was it simply a question of atomic bombs and mutually assured destruction. Rather, the USSR’s overall scientific and technological strength meant that if the United States failed to keep up—in all facets, from material results to personnel ‘manpower’—Moscow would be in a position to make the democratic world bow to its heel.

In a memorandum in September 1957—just ten days before unexpected the launch of Sputnik reoriented the debate once and for all—Alan Waterman wrote that the National Science Foundation was “gravely concerned about the possibility of reduced budgets for scientific research and development and retrenchment in contracts and grants for the support of basic research.” After an exasperating decade of trying to alert politicians and the public alike to the need for state support, Waterman declared that “it should no longer be necessary to ‘justify’ the interest and concern of the Federal Government in the continued development of the basic research resources of the United States and their effective utilization.” The funds available to the NSF for the fiscal year 1957, he warned, were sufficient to support only about one-third of the project applications considered scientifically meritorious. The proportion was slated to be even less in 1958. Damningly, “on a Government-wide basis the situation could become even more serious, particularly if basic research programs are singled out as attractive targets” for “meat-ax” budget cuts.177 As research became more expensive; as the budgetary needs of Big Scientific and high technological facilities and laboratories mushroomed; and as the global fight for technoscientific primacy heated up; the previous decade of

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halfhearted state engagement, haphazard coordination, ‘boom and bust’ fiscal commitments, and the ebbs and flows of the nation’s war footing determining scientific interest, had taken its toll.

The nation’s conception of technoscience had been contoured by industrial promotion and state laggardness. The lessons and technological spoils of the war had been diffused among competing interests. Varying creeds on the proper role of science and technology in society and on the role of the state in science and technology had been allowed to arise in the resulting ideological vacuum. The growth of a civilian, comprehensive research and development paradigm was stunted by politics, and its deployment across the rest of the state fared little better. The result was that the American state closed the door on a certain kind of state-science and technological power—a peacetime, civilian-oriented, collaborative, and open one.

It is ironic, then, that it was precisely a self-image of benevolent, peaceful, civilian power that the United States sought to promulgate abroad in the technodiplomacy of the Cold War, particularly after 1957. As this chapter has shown, however, the domestic political and bureaucratic underpinnings of such an image were far too precarious to support a cohesive international foreign relations program based on benign scientific and technological strength. That contradiction torpedoed several key efforts to embed technoscience into diplomatic and development strategies in the 1940s and 1950s. We will explore those efforts in the next chapter.
Chapter 4: Fits and Starts

In the early 1940s, English-speaking audiences on both sides of the Atlantic began encountering something new at the cinema. Far from being a chance for a few hours' respite from the horrors of war and the hardships of the home front, a trip to the movies instead offered a barrage of heroic war stories and gripping espionage thrillers. These genres, of course, had existed as long as cinema itself, but by the end of World War II, something about them had changed. While 1930s spy movies like *The Man Who Knew Too Much* (1934), *The Spy in Black* (1939), and *Mata Hari* (1931) tended to involve attempts to uncover double agents and to thwart invasions, attacks, bombings, and assassinations, by the 1940s the world of spies began taking on a different look. In *Above Suspicion* (1943), two American newlyweds were tasked to find a scientist in Europe who could provide the Allies with secrets on a new Nazi seaborne weapon. In the French noir film *The House on 92nd Street* (1945), agents worked against the clock to uncover a New York spy ring stealing secret atomic technology. In Fritz Lang’s *Cloak and Dagger* (1946), an American agent (based loosely on the real figure of J. Robert Oppenheimer) combed Switzerland and Italy to try to ‘turn’ a German scientist for the cause of Allied atomic research. And while Alfred Hitchcock’s *The 39 Steps* in 1935 had centered merely on the theft of “secret information,” the film’s remake in 1959 hinged on the clandestine struggle over “Boomerang,” a fictional British ballistic missile program.
International subterfuge, statecraft, and espionage, in short, had become a question of technology.

These were mere entertainments, of course, thrillers on the silver screen. But what they hinted at was a genuine sea change in international relations in the postwar world. In a newly technological landscape in foreign affairs, the peacetime maintenance of national R&D mattered just as much to global status as the ability to raise an army or mobilize resources for crises. As naval intelligence officer C.L. Coombs told Congress in 1952, “From a security standpoint realistically there is no substantial difference between a state of emergency involving arming to meet the threat of aggression under present world conditions, and the actual state of outright war. The protection of classified material, plans, operations, research, and development is more important in the planning and development stage strategically than later when the end product or machine of war is in actual use tactically. Our principal advantage over unfriendly foreign powers at present lies in our technology and know-how.”

But this was not just a question of war. While it is doubtful that many of the moviegoers enjoying Cloak and Dagger would have managed to slog through the 1947 Steelman Report on U.S. science and technology bureaucracies, if they had they would have encountered a dire warning from the White House that a new sort of international competition was looming: A struggle between the economies and militaries of technological powers. High-tech industrial economies would invariably

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1 For a reflection on the changing role of technology in espionage, see Kristie Macrakis, “Technophilic Hubris and Espionage Styles during the Cold War,” Isis 101:2 (June 2010), 378-85.
become “state-directed in the interest of national policies” and “supported by new, highly efficient industrial plants and equipment—by the most modern technology.” While American R&D was sufficiently advanced that “there is no immediate prospect that we shall fall technologically behind,” it was nevertheless crucial that the U.S. begin to “rely largely upon our own efforts in the basic sciences” in order to remain ahead of global rivals. As the report warned gravely, “the danger lies in the future.”

Steelman was not alone. In fact, a new formulation of U.S. global power based on the strength of American technoscientific might relative to other countries had become a commonplace at the highest levels of political power by the late 1940s and early 1950s. As Harry Truman wrote near the end of his presidency, “No thinking citizen can fail to recognize the swift rise of science in the last decade, to a point where it exerts an enormous influence in the structure of world power and peace. No one can successfully dispute the importance of maintaining and increasing in this country the vitality of the basic research upon which all technological development—and therefore our economic progress and national security—is dependent.” Not only, then, were science and technology important factors in the postwar world, but leaders up to the level of the White House now believed that the strength of the nation depended on them.

This new technological measure of global standing emerged at just the same time that the United States ascended to the position of global hegemon. The two rose together—the new standard

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4 Harry Truman, Letter of Transmittal, first annual report of the National Science Foundation, January 15, 1952, Alan Waterman papers, box 24, Washington, D.C., LoC.
and the new standard-bearer. But in neither case was the rise entirely smooth. The problem was that the ideas and ideologies of the leaders crafting America’s new role in the world outpaced the capacity of the American state to put those ideas into action. It was all very well for globalist thinkers like Truman and Steelman to demand that the U.S. exhibit global leadership in both diplomatic and technological ways, but the question remained: Did the United States have the expertise, resources, and political will to heed them?

The pivot toward American global engagement was shaped partly by a turnover of personnel in Washington. By the end of the 1940s, the direction of international security policy shifted from the influence of officials like George Kennan and George Marshall to new decisionmakers like Dean Acheson and Paul Nitze. Kennan and Marshall’s generation had been steeped in the foreign policy paradigms of the 1920s and 30s and therefore, according to John Thompson, “at some level America’s position in the prewar world remained for them a sort of norm.” Acheson, Nitze, and others, meanwhile, came to international affairs only in the globally oriented and technology-steeped context of World War II, and accordingly viewed the need for constant engagement, military readiness, and massive mobilization through that lens.5

Even then, however, the American awakening to a newly active role in the world was sluggish. In Acheson’s own words, “Only slowly did it dawn upon us that the whole world structure and order that we had inherited from the nineteenth century was gone and that the struggle to replace it would be directed from two bitterly opposed and ideologically irreconcilable power centers.” The world of

Cordell Hull—a vision based on the League of Nations, Wilsonian liberalism, and “a utopian dream”—slowly but inexorably leaked out of U.S. foreign policy thinking, and in trickled the hard-headed notion that “the hope of the world lies in the strength and will of the United States… and in its good judgment as well.”

The rollout of a new sense of international responsibility was thus tentative in the first years after the war. On one hand, the nation was now increasingly relying on a new class of professional thinkers who explicitly styled themselves as “the foreign policy elite,” exemplified by the Johns Hopkins School of Advanced International Studies, founded in 1943 to prepare a new generation of diplomats for the kinds of global responsibilities that would inevitably await the United States in the postwar world. On the other hand, prewar principles of withdrawal and disengagement remained surprisingly persistent—for example, for several years after the war it was commonly believed that Germany should be kept in a kind of pastoral torpor, and that the reconstruction of the world’s democratic states was, as Acheson observed, “capable of being met by semiprivate charity.” And protests verging on mutiny erupted among American troops abroad, as those in the field yearned for

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8 Acheson, *Present at the Creation*, 726.
home and resented the continued occupation of defeated territories, no matter their role in a broader strategy or vision of power.9

As it was with foreign policy, so it was with technoscience. As historians have comprehensively detailed, at the end of the war American scientists turned *en masse* to international political issues. Their first forays into foreign policy centered on internationalism and nuclear control, but their public mobilization failed quite quickly. Political leaders disregarded scientists’ seemingly utopian ideas, and rising anticommunist impulses led to restrictions on their professional exchanges and political activities.10

Scientists did, however, increasingly succeed in articulating a cohesive new vision of technoscience as global power. As Johns Hopkins’s Isaiah Bowman urged Congress in 1946, “it is commonplace that the United States has entered upon a time of enlarged responsibilities, indeed of new responsibilities in international affairs. We cannot discharge those responsibilities unless we maintain a front position all along the line, and science is one of the chief means of maintaining a front position. The scale on which we should operate from this time on, in the United States, is a scale as large as our responsibilities.”11

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10 Manzione, “Amazing and Amusing.”

Vannevar Bush agreed. “It may be,” wrote Bush to the influential budget administrator James Webb, “that our standing and ability in some field of science which is now regarded as academic will determine whether or not this country can maintain its position in the world. But every individual who sees the current of the times will, I am sure, agree that this country must be strong in its entire scientific effort, and must have an ample supply of skilled scientific men for its affairs… Our whole future may well revolve about the question of whether or not we do this thing well.”

Scientists deigning to inform legislators and policymakers as to the sources of U.S. power represented something new in American history, and were enabled specifically by the role technology had played in the war, as well as by the new ways—both material and abstract—in which the United States now found itself relating to and interfacing with other global powers. The new, technological vision of international relations promulgated by Cloak and Dagger, it turned out, was not too far from the truth.

Nevertheless, what science and technology researchers said and how they were accepted by those in power often diverged wildly. Despite the fact that R&D personnel and foreign policy elites both habitually insisted that the “diplomat and scientist owe it to mankind to help each other,” in reality the American state—and its political paradigms and foreign policy machinery—was too large a battleship to change course quickly. Well into the 1950s, new, large-scale international science and technology programs remained controversial and difficult to implement. The State Department was populated by personnel with entrenched worldviews inculcated well before the war. Leaders both in

12 Letter, Vannevar Bush to James E. Webb, May 13, 1947, box 87, Vannevar Bush papers, LoC.
Washington and in the field were often skeptical of new ideas and global commitments, and usually unready to execute them. While some policymakers strove to reorient government resources toward technoscience, others ignored those efforts or undermined them through heavy-handed security regulations or the wanton withdrawal of resources. As Caltech president Lee DuBridge noted, “those of us who are less experienced… still think of ‘the government’ as an entity with a mind and purpose. And we shall never get over the shock of seeing the government do one thing with one hand and a wholly contradictory thing with the other.”

This chapter, like the last one, is about technoscience champions and their discontents, this time in the realm of foreign policy. It argues that before the late 1950s, rhetoric and exhortations about the importance of science and technology to U.S. foreign relations, which were on the rise in this period in an unprecedented and irrepresible way, nevertheless far outran the reality, resources, and will to implement them in the American state. As DuBridge put it, “The history of government relations with science is replete with examples of good intention and bad implementation.” During these years there existed no shortage of technoscience philosophers and acolytes—including up to the level of diplomats, agency heads, and presidents. Yet the collective weight of these groups’ worldviews and mobilization was insufficient to construct a cohesive and comprehensive foreign policy for science and technology before 1957. From the State Department to the CIA to the White House, the

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14 Address, Lee A. DuBridge, “Science Serving the Nation,” Johns Hopkins University, October 16, 1954, Vannevar Bush papers, box 184, LoC.
15 Ibid.
ability of the United States to channel global power through a clear-eyed exertion of technoscientific diplomacy was lacking—at least in the civilian realm.

As we have seen, by the height of the early Cold War science and technology had come to be seen by most Americans as something innate to the national character. ‘Yankee ingenuity’ was a unique gift, and represented something the country had been good at since at least the end of the nineteenth century, if not all the way back to Benjamin Franklin. As a result, in the early postwar period we can observe technoscientific power as discursively feeding into the impulse toward “low cost internationalism” that had been previously pursued by Woodrow Wilson and Franklin Roosevelt.16 As the National Research Council warned in 1950, the United States could never match the kinds of resources and population mobilization of the totalitarian USSR. As a result, “we must maintain our scientific and technological leadership both for the improvement of the peaceful arts and for the technological superiority we must have to offset the numerical superiority of our potential enemy.”17 The Soviet atomic bomb, as well as the stalemate end of the Korean War, crystallized the notion that American defense should consciously, in the words of Dwight Eisenhower, “depend… for increased efficiency more upon modern science and less upon mere numbers of men.”18 Technology as a replacement for costly national resources and wavering political appetites thus marked a

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16 See Thompson, A Sense of Power, Chapter 6.
continuity from Truman to Kennedy, even if its names—NSC-68, New Look, Flexible Response—were different.19

In this vision, technology would represent the key to national strength in both peace and war. High-tech industry would provide both unmatchable commercial products and unbeatable weapons systems. The U.S. would build up such a preponderance of them that, in the words of Bruce L.R. Smith, “if there were some leakage of military technology or if a foreign competitor acquired commercial secrets by unfair means, the annoyance would be unlikely to erode American security or technological leadership.”20 American technoscientific hegemony would thus not be total, but would be large enough to reasonably absorb any challenges. Most attractively, it would be a relatively inexpensive form of global influence, based as it was on something that was already inherent to the nation’s character and strength.

But science and technology were not low cost. As Americans discovered, the types of projects that were in vogue in the postwar years—Big Physics, unprecedentedly powerful weaponry, international aid schemes—were among the costliest initiatives a society could bear. Moreover, pursuing them at the kinds of scales that might make a real geostrategic impact—as in the reconstruction of the industrial economies of Europe, or the assistance of developing nations increasingly in the strategic crosshairs of the global Cold War—made clear that half-hearted

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19 For a discussion of policy elites’ views on the use of technology to minimize the costs and resources of war, see Stephanie Carvin and Michael John Williams, Law, Science, Liberalism, and the American Way of Warfare (New York: Cambridge University Press, 2015), 92.
deployment and wavering commitments could not only be counterproductive, but might actually cause indelible harm to the national interest.

But discovering these truths took time and hard experience. The first decade and a half after the war, then, represented a time of growing pains for the United States, both in overall geopolitical engagement and in the growth of science and technology as a key aspect of it. This chapter will focus on three major case studies to illustrate this torturous growth process, as well as the effect they had on the shape of U.S. hegemony in the Cold War.

First, it will explore the brief rise and rocky fall of the State Department’s science attaché program, which was designed to place U.S. technoscience experts in embassies worldwide to conduct an ambitious—and very visible—new practice of international relations. From the beginning, however, foreign observers were skeptical of the initiative, believing either that the inexperienced Americans were taking on too much with such a program, or that they harbored ulterior motives. Getting both U.S. scientists and diplomatic staff to buy in and present a united front to the world, moreover, proved impossible. By 1955 the program was gone. The attaché initiative demonstrated that the lessons of the importance of scientific diplomacy from the Second World War had been well-learned by some, but also that the construction of new formulations of power can often be fraught in terms of their execution and reception.

The chapter will then explore the evolution and implications of the failed Point Four program, which represented the first conscious attempt by the United States to leverage its scientific and technological advancements for the achievement of foreign policy objectives on a global scale. But
what began as a technical development ideology quickly became a painful case study of why “low cost” hegemony could neither apply to science and technology, nor be compatible with the massive ideology of containment.

Finally, the chapter will explore the ways in which all such attempts to deploy technoscience as a component of international identity were shadowed by the midcentury specter of security paranoia, which produced a ‘chilling effect’ on both the conduct of science at home and the interchange with research communities abroad. Historians have written extensively about the disastrous interactions between scientists and the national security state during the McCarthy era and beyond, but the purpose of this discussion is to consider those security scares in the context of an evolving formulation of global power. I will argue that the ostensibly anti-scientist security ‘chill’ represented, seemingly paradoxically, a consummation of the overriding belief in the primacy and importance of Yankee technoscientific might. So confident was the United States that it possessed key technological advantages—and so warped did public and government understandings of the research process become—that security procedures grew to defy all logic, as policymakers obsessed over protecting American advantages, and officials from the State Department to Congress attempted to put a moat around scientific activities that they erroneously believed to be homegrown. Policymakers’ security paranoia exhibited a deep concern for the international importance of technological achievements, even as it also involved an attempt to protect those achievements in a way that scientists found galling.
In all of these cases we see a common thread of duality—a palpable awakening to the global power dynamics of science and technology in the United States, but also a concurrent inability or unwillingness to commit to its development. In short, the government—just as in the context of domestic scientific statebuilding from Chapter 3—was often simply contradictory, messy, or at cross purposes with itself. As the Pulitzer Prize-winning journalist Ben Bagdikian wrote at the time, “One arm of government pays experts to analyze Russian publications and another arm of government burns the publications before the experts can see them. One arm of government pays foreign scientists to come here and another arm of government consistently turns them back. And today informed men can present disturbing evidence that incompetence, politics, and senseless prejudice in the security system have made it possible for anti-American forces to manipulate the system against America itself.” These contradictions represented “typical debits in the ledger of American security.”

These contradictions are all the more remarkable when we consider the way that tech-diplomacy did ultimately move to the center of U.S. foreign policy in the 1960s. The ideas of technoscience champions ideas were taken up haphazardly—and sometimes even ignored outright—for years, but that very laggardness is historically important, since it represented the context in which the sense of science and technology as U.S. power evolved and crystallized. Because their ideas were implanted into the state and foreign policy apparatus in fits and starts, technoscience advocates were continually required to engage and reengage with the political process, and to refine and repackage

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their beliefs for public and policy consumption. The payoff wasn’t immediate, but the results would prove other-wordly, as the difficult first decade after the war saw the creation of a ready-made set of ideas ready for massive deployment after humanity first left the earth in 1957.

As John Thompson has written, policymakers “know that it is impossible to sustain policies that make substantial demands on the nation’s resources without public support. Because the behavior of the United States in the international arena is the product of this interactive process, any attempt to explain it must examine the factors that shaped public and congressional opinion as well as the thinking of ‘policymakers.’” Chapter 3 examined the domestic part of that dialectic, showing us that the American public and politicians recognized the importance of technoscience, but disagreed sharply on whether it was something innate or whether state resources were required to foster it. As we will see in the coming pages, this patchy state commitment to R&D also translated to the international arena, and bounded the ability of the United States to conduct effective technodiplomatic programs in the first decade after the war.

The Undiplomatic Diplomats: The Science Attaché Program, 1950-55

The State Department had been weakened by the Second World War.

By political, bureaucratic, and strategic necessity, the conduct of foreign affairs became vested heavily in the White House under Franklin Roosevelt, while major policy and strategic decisions continued to be dominated by the military and security apparatus throughout the Truman years. This

22 Thompson, A Sense of Power, p. 23.
situation was both embarrassing and untenable for the diplomatic corps as the war became more
distant, and the first two postwar Secretaries of State—James Byrnes and George Marshall—grasped
for potential solutions that might reinstate the department as the central clearinghouse for foreign
affairs in peacetime.

One solution that seemed particularly promising was for the department to take up the
mantle of science and technology. As we have seen, the early years after the war saw a dawning
recognition among some diplomatic planners, technoscience lobbyists, and the White House that
science and technology represented a crucial element in the conduct of U.S. foreign relations. It
followed, then, that if wielded correctly, a robust program of scientific and technological diplomacy
could provide the State Department with enormous leverage to claw back a degree of influence over
American foreign relations, especially if it could provide a material counterweight to the ballooning
influence of the military.23 As undersecretary James Webb wrote to the NAS, “As an integral part of
its reorganization, the Department of State desires to define its role in the field of science and to
insure [sic] the most effective utilization of its facilities for the benefit of science in this country.”24

There was a glaring impediment to this plan, however: American diplomats possessed little
familiarity with the workings or policy implications of science. The government had pivoted toward
R&D so quickly during the war that international R&D channels were largely improvised by agencies

War America,” in Jeroen van Dongen, ed., Cold War Science and the Transatlantic Circulation of Knowledge (Leiden:
24 Minutes, Committee on International Science Policy, National Academy of Science, April 26, 1950, box 79,
Vannevar Bush papers, LoC.
like the OSRD and the Navy. The State Department, populated as it was by civil servants and elites with liberal arts pedigrees, played very little role in interfacing with the Tizard Mission, and prior to the war had spent almost no energy or resources on technoscientific matters.\textsuperscript{25}

Illustrative of this paradigm was an ornery statement released in 1950 by the State Department’s emissary to the U.N., John Cates, Jr., which revealed just how incohesive U.S. technoscience planning remained, a half-decade after Hiroshima. Responding to a questionnaire about the relation between U.S. science policy and budding international organizations like the WHO, WMO, ICAO, and FAO, Cates shot back that such a question had no application at all to any such agencies. “I do not know what is meant by ‘policy,’” he noted, and “in any event, I do not believe any additional ‘mechanisms’ are required.” As far as the U.S. was concerned, “there is no policy on ‘science’ as such,” although Cates conceded that “we are aware of certain shortcomings which the State Department and other departments are endeavoring to overcome.”\textsuperscript{26}

These shortcomings were becoming more urgent as national security elites fixed their gaze upon the foreign relations implications of science and technology. In January 1949, the National Security Council issued its first-ever directive outlining the collection of “scientific and technological information required from foreign areas in the interests of national security.” Specifically, NSCID-2 (subsequently revised in NSCID-10) entrusted the State Department with primary responsibility for this task. The NSC also quickly expanded the definition of “basic scientific information” to include

\textsuperscript{25} Ibid.
\textsuperscript{26} John Cates, Jr., “Questionnaire on Scientific Interests of the United Nations Itself or Specialized Agencies,” January 19, 1950, RG59, Bureau of Scientific and Technological Affairs, Central Files, Entry 3008D, box 3, NARA.
nearly all science and technology-related matters in the world that were not explicitly military in nature.\textsuperscript{27}

The State Department thus found itself with little choice but to appeal for expertise and planning ideas directly to scientists themselves. In 1949 the Department requested Lloyd V. Berkner, a distinguished atmospheric scientist who had previously worked for both the government and Carnegie Institution, to compile a report detailing what the nation would need to do to integrate science and technology into foreign policy. Berkner was an auspicious choice. A true technoscience advocate, he had spent years lobbying for the construction of an all-encompassing government R&D program in order to solve the issues of the nation and the world. In contrast to Vannevar Bush, Berkner’s priorities were explicitly diplomatic and global, envisioning a dialectic of increased technoscientific capacity at home and a new primacy for it abroad. His summary of these issues for the State Department, “Science and Foreign Relations” (the Berkner Report), was released in April 1950.\textsuperscript{28}

On its surface, the meticulously-researched 170-page report boiled down to a handful of major proposals. These included the notion that the U.S. should actively foster international scientific


exchanges, and that the government’s foreign policy elites should seek closer relations and accessibility with the R&D community. The State Department should better support private R&D organizations, as well as intergovernmental ones like UNESCO. Most importantly, diplomatic planners should work to overcome the boundaries of suspicion between themselves and the science community. They should appoint a committee of preeminent NAS scientists with security clearances to act as a top-level advisory board; establish a new Science Office within the Department of State to provide scientific and technological judgment on foreign policy decisions; and most critically, equip embassies worldwide with overseas science and technology officers, replacing and consolidating existing military science missions.29

Beyond these practical proposals, the report—which carried contributions and endorsements from a group of National Academy of Sciences luminaries, including Bush, I.I. Rabi, Detlev Bronk, and Roger Adams—represented a milestone in underlining the newly inextricable interrelation of science and technology with world affairs. This was a new paradigm that now demanded “top policy consideration and the aid of professional scientific judgment.” If Science: The Endless Frontier had been written with the assumption that Americans in peacetime would be most concerned with the domestic welfare of the nation, the Berkner Report now articulated the stark consensus that “post World War II government policy on domestic issues has been overshadowed by matters of foreign policy.” Such a persistence of outward focus after a war was unprecedented in U.S. history, of course.

The importance of science and technology to the outcome of that war, however, meant that a robust state complex of R&D would now necessarily be central to the proliferation of programs and initiatives inherent to the United States’s new role in the world.\textsuperscript{30}

It was a role, Berkner insisted, that hinged on the strength of the United States itself, a measure that depended to a new degree on its muscle in science and technology. While the report paid heed to the cooperative rhetoric of scientific internationalism and the promises of multilateral knowledge exchange, it repeatedly yoked these concepts back to the accrual to the United States itself of hegemonic economic and defense capacity. In short, American security was linked to global stability, and global stability was dependent in part on research advances. Berkner affirmed as such when he asked, “Are we weighing the consequences of our day-to-day decisions on the progress of science and technology? Are we exploiting the sources of information reflecting the progress of science and technology so vital to our own security and the welfare of free peoples everywhere?”\textsuperscript{31}

“Science and Foreign Relations” was an influential document that was widely circulated abroad. International observers took its publication as a vital sign that the United States was pivoting toward science and technology in the diplomatic arena. The British government, in particular, sent copies to numerous of its own ministries for internal study. As the Foreign Office there noted, the State Department seemed to have awakened to the importance of research not only for the welfare of the U.S. itself, but for its global interests. The Americans appeared to recognize “the close inter-relation of scientific development” with economic welfare and political security, and had seemingly

\begin{itemize}
\item \textsuperscript{30} Ibid., 5.
\item \textsuperscript{31} Ibid., p4.
\end{itemize}
accepted the maxim that technical assistance could bring about strengthened and self-supporting economies throughout the free world. Most importantly, they now accepted that U.S. defense interests now absolutely required “that American scientists should be kept abreast of advances in technology abroad.”

The most important program that Berkner proposed was the placement of American R&D liaisons—science attachés—in overseas embassies. This did not represent merely a bolstering of staffing or a bureaucratic maneuver. Rather, it was intended to serve as a dramatic step towards the wholesale integration of science and technology developments with foreign policymaking, in arenas both above-board and clandestine. This was vital work, and the State Department seemed the best place for it over other agencies, since it already had a physical infrastructure in the form of embassies. More abstractly, it belonged in State because, in the words of an NSF memorandum, “our foreign relations and our broadest national interests are increasingly closely allied to science.”

The attaché program traced its roots to the robust transatlantic research exchange that had been created with Britain during the war—we have already seen, for example, the especially crucial bilateral role afforded to the OSRD’s London office. In a conscious effort to build on the successes of

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32 Part of their interest lay in the fact that Berkner had praised and suggested emulation of the effective science liaison organizational example established by the British Commonwealth Scientific Offices in North America. British officials also noted with satisfaction that Berkner sought to emulate the manner that Britain and France had carried out their scientific responsibilities in postwar occupied Germany. American Department, Foreign Office, “The Role of the State Department in Science,” July 12, 1950, FO 371-81768, UKNA.

the British liaison, in 1946 the office of Willard Thorp, Assistant Secretary of State for Economic Affairs, launched an analogous program in the State Department, dubbed the London Science Staff. Thanks to the effectiveness and scale with which the OSRD had conducted its overseas activities—free as it had been from extensive political or fiscal oversight—this early State liaison scheme maintained a surprisingly robust cadre of specialists in Britain, drawing in experts from biochemistry, organic chemistry, surgery, bacteriology, plant physiology, agronomy, zoology, genetics, and engineering. Its Chief Science Officer was Dean Woolrich, head of the College of Engineering at the University of Texas.34

The Staff was active in trying to foster multilateral science and technology programs, and was curious to study and learn from other countries’ systems of innovation. Under Woolrich, the London office undertook a comprehensive survey of the mechanisms and operation of Britain’s government-directed research, focusing especially on the activities of the DSIR. Beyond the British Isles, the office took part in a major joint project with the Economic Cooperation Administration (ECA, the administrator of the Marshall Plan) and the Organization for European Economic Cooperation (OEEC) to promote interchange of industrial and agricultural technology among Western European countries. This was intended as a technical complement to the Marshall Plan, with the goal of strengthening the economic recovery of the continent. The staff thus gained two years of multilateral coordination experience by the time Lloyd Berkner began compiling his report, and their activities

became so promising and successful that when Berkner formulated his proposal for a global science attaché program, it hinged on the absorption of the LSS and the adoption of its procedures.\textsuperscript{35}

As delineated by Berkner, the new State Department science attachés’ responsibilities were to be similarly multivariate and ambitious. Ideally, the attachés were to be eminent scholars, who could lend scientific cachet and gravitas to American embassies. Attachés were to collect and disseminate foreign research; support international scientific activities and exchanges; proffer technical assistance to host countries; render services to American scientists and organizations; liaise with other agencies in scientific and technological matters; and help to bring such matters to bear overall on U.S. foreign policy objectives. As an intelligence summary later put it, the job was to “monitor the impact of science and U.S. foreign policy on each other.”\textsuperscript{36}

This was a gargantuan charge for an agency with no prior science experience outside of Thorp’s London office. The department would not only have to convince career diplomats and bureaucrats of the importance of science, but would also have to convince scientists that the diplomatic corps understood and respected their worldviews—to say nothing of forging research relationships with other nations. The enthusiasm of the NAS, for one, was measured—the program could be effective, but only if scientists of “extraordinary caliber” were found to staff it. As the academy’s international committee judged it, “if the right men were chosen for the Science Office in the Department of State and for science posts abroad the plan would work. Otherwise there might be

\textsuperscript{35} George V. Allen, Assistant Secretary for Public Affairs, “Where Do We Stand on Point Four?,” \textit{Department of State Bulletin}, July 4, 1949.

considerable difficulty in having an influence on policy guidance in Washington and abroad. In addition to scientific attainments, personality and language qualifications would of necessity be important."37

The geographical scope of the plan was equally ambitious. There was to be an upper tier of regional offices in London, Johannesburg, Rio de Janeiro, and Sydney or Canberra. Below it would be a more pointed country-by-country network of attachés, who would be appointed for two years and given full diplomatic status and a small team of employees. Initial deployment of this latter group was suggested for Paris, Rome, Bern, Stockholm, Ottawa, Lima, Oslo or Copenhagen, The Hague, and Brussels.38

The plan was approved and set in motion in 1950, with the appointment of two attachés to London. A year later, two more were sent to London, as well as two each to Stockholm and Bern. A year after that, four more were added, being dispatched to Paris and Bonn. Thus, for a few noteworthy weeks in mid-1952, the U.S. had eleven science attachés placed in five foreign capitals.39

This was to be the high point of the program, however. In reality, the State Department’s overall commitment to research in foreign policy was not as comprehensive or ambitious as the London Science Staff would make it seem. Berkner’s proposals, while hardly falling on deaf ears, were nevertheless dashed on the rocks of ambiguous policymaking, bureaucratic incompetence, and the

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37 Letter, Roger Adams to Dr. Alfred N. Richards, April 26, 1950; and minutes, Committee on International Science Policy, National Academy of Sciences, April 26, 1950, box 79, Vannevar Bush papers, LoC.
38 American Department, Foreign Office, “The Role of the State Department in Science,” July 12, 1950, FO 371/81768, UKNA.
lack of full consensus on wielding science and technology in the foreign policy arena before the end of the 1950s.

A major reason for the failure of the attaché program itself was the botching of one of its most important, if top secret, responsibilities—intelligence. The Berkner Report had contained a secret supplement, carefully coordinated with the CIA, which called for the State Department to take a primary role in intelligence-gathering and the monitoring of foreign scientific and technological activities. Since R&D intelligence now represented a vital national security matter, the attachés were intended to be crucial backchannels for its collection. In common with the attaché program as a whole, however, the State Department implemented this vital aspect in a haphazard way.

Few—possibly even none—of the attachés sent to embassies were given any actual explicit instruction about intelligence collection, and indeed, preferred to think of themselves in more idealistic, internationalist terms. Being drawn from the science community, the attachés tended to harbor the profession’s cooperative and universalizing impulses. They saw themselves as ambassadors, not infiltrators. William Forbes, the Paris attaché, wrote sternly in the *Bulletin of the Atomic Scientists* that a science diplomat “must never act as a spy. He should avoid taking more than he gives,” including anything that might give the appearance of “picking the brains of scientists abroad for the benefit of American science or industry.”  

Such attempts to maintain idealized scientific-internationalist principles caused friction with career diplomatic staff, who little understood science or its priorities, and who often saw open

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40 Ibid.
international cooperation between researchers as smacking of communism.\textsuperscript{41} They also to some extent defied the nationalist tinge of the Berkner Report, which, although acknowledging that global uplift was the goal and interest of the United States, nevertheless underscored that diplomatic engagement with science and technology abroad would primarily “enable[…] the American scientist to exploit directly the discovery and lines of thought delineated by other scientists and to build upon their accomplishments.”\textsuperscript{42}

As if this divergence of mission were not obstacle enough—and despite the fact that the classified Berkner Report annex detailing the intelligence objectives was publicly unknown at the time—foreign observers \textit{already} believed the attachés to be spies. Amid the ongoing scientific reconstruction of Europe and the resurgence of postwar nationalism—centered, in new ways, on the buildup of national and regional technological capacities—an abrupt infiltration into European capitals of eager American science diplomats on the government payroll was met with suspicion.\textsuperscript{43} As European science luminaries like Frederic Joliot-Curie fulminated, the program was clearly nothing more than imperialistic American espionage. Likewise, when the two attachés to Germany arrived in Bonn, a local explained to one of them in confidence that “most Germans regard you as a spy.” Naturally, the scientific ambassadors found that their telephones never rang, and the Bonn office was

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\textsuperscript{41} Ibid.
\textsuperscript{42} Berkner, “Science and Foreign Relations,” p. 3.
\end{flushright}
The obvious chilling effect of this characterization meant ironically that the attachés could function *neither* in an intelligence *nor* peaceful capacity, because they were seen as spies either way by foreign scientists. Try as it might, the U.S. could not seem fully to commit to or convince others of its new peaceful technoscientific identity.

The nail in the coffin for the program came in June 1955, when a new Hoover Commission report bluntly called for scientific espionage activities to be moved from their current home in the State Department to the CIA, with any further science attachés to be appointed under the Agency’s remit. The problem was that the public had not known that scientific intelligence activities were being conducted by the State Department in the first place—the Hoover report was accidentally published without classification, to the great embarrassment of both agencies. The faux pas had predictable effects on foreign exchanges with embassies, but more gravely, it also made it nearly impossible to recruit any more eminent scientists for overseas posts.45

The attaché program also met hostility from other agencies of the U.S. government. The Navy, which had maintained a considerable liaison program in London since the war, steadfastly opposed the State Department getting involved in foreign science. In the words of historian Harvey Sapolsky, Navy attachés believed that State “would be certain to bungle the job of maintaining the ties with

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European science if it had the responsibility, and it was extremely doubtful that the State Department could recruit scientists to do the work. There was no point, it seemed, in giving the department any meaningful role in the foreign relations of science."46

The National Science Foundation, too, began to wonder if it should dispatch its own foreign attachés to complement or replace those from the State Department. But while it was believed that this would improve U.S. foreign science policy, the Foundation ultimately failed to try it. As an internal memo authored by National Science Board secretary Neil Carothers hinted in 1954, although the State Department was doing a substandard job, an NSF proposal for a takeover of foreign programs would never be accepted by the Budget Bureau or Congress unless the NSF openly criticized the department, which it wasn’t prepared to do. In any case, Carothers noted, State seemed a better fit “on paper,” due to the local power of U.S. embassies and the higher salaries State was authorized to pay for top-flight scientists.47 Given the woeful ineffectiveness of the State Department’s program that we have seen, the fact that the NSF nevertheless saw it as the most appropriate agency to run an effective science and technology program abroad underlined the overall weakness and uncertain future of U.S. technoscience foreign policy in the mid-1950s.

The attachés themselves bemoaned the lack of support they received from the State Department. Ralph Wyckoff, the London attaché in 1954, complained that although he received the official papers on all delegates to science conferences in Britain, they almost never came to the

46 Sapolsky, Science and the Navy, 53.
embassy to see him. His office was staffed embarrassingly not by senior scientists but by “boys.” He himself had not visited any British research establishments, nor sought to obtain entrance for visiting Americans, but instead waited for invitations that never came. This combination of humiliations, he was sure, “makes American science lose face abroad,” to say nothing of rendering it vulnerable to the critiques of communists in host countries who, he noted, had begun incorporating science matters into their diatribes on U.S. foreign policy.48

In the end, the science attaché program died with a whimper. The ongoing recruitment and espionage problems were exacerbated by increasingly strident budget cuts from leaders who were as yet unconvinced of the value of science and technology to foreign policy. Particularly damning was the transition from Secretary Acheson to John Foster Dulles, who took little interest in the program, and who oversaw an enormous general reduction of State’s program budgets.49 Dulles opposed dedicating resources to international science to such a degree that the Ford Foundation was obliged to step in to fund the U.S. government’s participation in numerous international science bodies and conferences thereafter.50

As attachés dropped off the diplomatic vine one by one, the NSF and National Academy of Sciences pleaded for the program to be kept alive. The CIA even pledged to financially support it, no matter whether it was vested in the NSF or State. But all of these appeals were flatly denied by the

48 Diary note, Raymond J. Seeger, London, August 18, 1954, box 1, Alan Waterman papers, LoC.
Bureau of the Budget. By 1953—less than three years into operation—the financial resources dedicated to the program were so minimal that the department ceased trying to fill attaché posts as the incumbents resigned, and even declined to appoint a new official Science Adviser after its only ever permanent incumbent, Joseph Koepfli of Caltech, resigned. By the end of 1953 the budget cuts left only four attachés in the service—those in London, Paris, Stockholm, and Tokyo—backstopped by just a single professional staff member in the State Department. By 1955 there were no attachés left all.

On the eve of Sputnik, this neglect seemed to those concerned with international relations to be a grave oversight in a world increasingly defined by scientific and technological power. As John Lear, the chief correspondent for New Scientist, argued in early 1957, the death of the attaché program was evidence that Eisenhower and Dulles were not only non-scientific, but anti-scientific, believing there to be no useful research outside the atom. The “dignity and authority” represented by the Science Advisor post had been destroyed, and the United States had been weakened as a result. This was all the more alarming, Lear noted, since both private U.S. industry and laboratories were now jumping headlong into foreign technological liaison activities. GE and IBM had both inaugurated European liaison offices in Zurich to keep abreast of the results emerging from

European—and Soviet, if possible—laboratories; Battelle Memorial Institute and the Stanford Research Institute also opened European headquarters in Zurich, appointing industrialists to interface with researchers in the region.55

Truly the foreign policy aspects of U.S. science and technology were fractured along many lines by 1957.

The Underdevelopment of Development: The Failure of Point Four

If the tribulations of the science attaché program represented a failure of U.S. technoscientific foreign policy toward industrialized countries, what of the situation in developing ones? Part and parcel, after all, of the new notion that science and technology was inextricably bound up in U.S. hegemony was the belief that national security was premised on global stability—and threats to stability did not respect borders. The United States pursued stability through a variety of mechanisms—from economic interventions like the Marshall Plan to hot wars against communist insurgents—and, as John Krige and others have detailed, a key part of this engagement in industrial states was scientific reconstruction.56 The political and financial will to wage similar campaigns in the developing world, however, little matched the schemes so energetically conducted in the developed. In fact, the most significant attempt by the State Department to use science and technology for uplift and development before the 1960s met much the same fate as the science attaché program, the Alien

56 Krige, American Hegemony and the Postwar Reconstruction of Science in Europe.
Property Custodian, and the annual budgets of the NSF. The global ideology of power behind the program known as Point Four, that is, proved to be no match for the depths of political apathy, corporate opposition, and lack of ingrained experience to conduct such an ambitious global scheme, by the midcentury American state.

In the mid-1940s, a minor U.S. official in the Office of Inter-American Affairs began formulating a new ideology of U.S. power. Stationed in Brazil and seeing inequalities there firsthand, Benjamin H. Hardy came to believe that technological strength possessed the paradigm-shifting power to positively offset “the social and economic conditions on which Communism thrives.” Hardy became a press officer for the State Department, and tried to convince his superiors there that his ideas could represent a powerful new valence of foreign policy. To his great frustration, however, his was but a minor public relations post, and his idea interested no one. Taking a significant professional risk, he decided to go over their heads. He decided to go to the White House.57

In December 1948, the 42-year old Hardy contacted presidential adviser George Elsey with a memorandum he had written called “Use of U.S. Technological Resources as a Weapon in the Struggle with International Communism.” The memorandum presented a forceful case to the White House: The core strength of the United States lay in its technological expertise and industrial progress,

and those, in turn, could be mobilized for a massive program to alleviate global poverty. The result would be global stability undergirded by American technology.\textsuperscript{58}

Hardy’s gamble paid off; Elsey was immediately taken with this new formulation of U.S. power. Indeed, the White House quickly went public with a version of the idea. President Truman said that it articulated a problem that had “been in my mind, and in the minds of members of the Government, for the past two or three years,” ever since the first brainstorming sessions for the Marshall Plan. And it seemed to jibe, the president said, with his constant preoccupation over the ways American strength could be wielded to solve global conflict. “I spend most of my time,” he told the press, “going over to that globe back there, trying to figure out ways to make peace in the world.”\textsuperscript{59}

Truman’s counsel and right-hand man, Clark Clifford, was also captivated by Hardy’s vision, and moved quickly to transform it into praxis. Hardy’s ideas were by no means universally accepted, but Clifford was a stubborn shepherd, and he accepted no opposition when he encountered it from other officials. When Clifford sent a draft public pronouncement on the proposals to the State Department’s Policy Planning Staff, for example, they balked at the idea. Both Paul Nitze and acting defense secretary Robert Lovett were hesitant to go forward with an idea they considered valueless,
but Clifford simply ignored their objections. The plan not only went public, but was incorporated into the President’s upcoming Second Inaugural Address.60

By the time Truman delivered it, a speech that had originally been intended to make a series of domestic political proposals had morphed into a manifesto almost entirely focused on the United States’s new role in the world, dwelling on the foreign policies that the president envisioned for the future.61 One of the key planks of that vision was Hardy’s idea to leverage American technological might for the uplift of the globe. Announcing the program that was to become known as Point Four—it came as the fourth of four major foreign relations proposals in the speech—Truman articulated a worldview suggesting that “the United States is pre-eminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for the assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible. I believe that we should make available to peace-loving peoples the benefits of our store of technical knowledge in order to help them realize their aspirations for a better life.”62 This proclamation represented the official launch of presidentially backed development strategy in U.S. policymaking.63

60 Acheson, Present at the Creation, 265
61 McVety, Enlightened Aid, 91.
63 For more on development in foreign policy see, Immerwahr, Thinking Small; Cullather, Hungry World; Edward Miller, Misalliance: Ngo Dinh Diem, the United States, and the Fate of South Vietnam (Cambridge, Mass.: Harvard University Press, 2013); Nils Gilman, Mandarins of the Future: Modernization Theory in Cold War America (Baltimore: Johns Hopkins University Press, 2003). Megan Black points out that Point Four historiography tends to assume a programmatic coherence around an ideology of social improvement in the Global South, as defined by the
Point Four was a significant step forward for the growing sense that foreign affairs were inextricably bound to technoscience. In a State Department policy document prepared for dissemination across the federal bureaucracy, the president reiterated that this “bold and new” program represented something unprecedented in elevating technology to a “position of major importance, in coordinating these activities into a vigorous and integrated program of action, and in seeking much greater participation in such a program by the other countries of the world.” The official put in charge of Point Four, longstanding State economist Samuel P. Hayes, echoed the president’s enthusiasm by boasting that the program was “the first time in history” that a world power was to brandish its “knowledge and techniques” as a central instrument of foreign policy.

These “knowledge and techniques” would be simultaneously ambitious and human-scaled. The State Department would lead the program, but it the work would be performed by State, the Department of Agriculture (USDA), the Interior Department, private firms, foundations, and other stakeholders. The U.S. would offer advice and technicians—2,000 of them, by the program’s end—for projects in agriculture, public health, and education. As Amanda Kay McVety writes, in these early days Truman administration planners were still “true low modernists, who tempered their scientific planning with consideration for the locally centered lifestyles of the people they wanted to help.”

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65 Macekura, “The Point Four Program.”

66 McVety, *Enlightened Aid*, 385
Industrialization was to come only in exceptional cases, like consultation for the construction of Egypt’s Aswan High Dam.\textsuperscript{67}

Hayes’s vision for Point Four reflected a mishmash of vague Weberian ideas, technological positivism, and a Horatio Alger-style ideology of self-sufficiency. As he later remembered, the power and uniqueness of the program was intended to derive from “an American or Western emphasis upon a technological approach to development versus either an authoritarian or an establishment and hereditary approach.” He noted that “the Protestant ethic kinds of cultural value were felt to be very important,” but also that “you don’t want to inhibit people’s belief that they can get ahead, because if you do, then they won’t undertake some of these changes that you want them to undertake.” Thus, technology seemed to be a new key to both providing aid \textit{and} fostering a bootstraps ideology in developing nations.\textsuperscript{68}

If this sounded vague, it was—the Point Four ideology was put together in fact vacuum, since no comprehensive studies linking technology to economic development yet existed. Nor had anyone shown a causal connection between technology transfer and political change. In fact, no major quantitative study comparing incomes across countries had even been conducted until eight years prior, when Colin Clark’s \textit{The Conditions of Economic Progress} appeared in 1940.\textsuperscript{69} Ideologies like Hardy’s, then, were \textit{new}, and in the absence of hard data, abstract claims that postcolonial states

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\item \textsuperscript{68} Oral history interview, Samuel P. Hayes, with Richard D. McKinzie, July 16, 1975. Harry Truman Library, digitized. \url{https://www.trumanlibrary.org/oralhist/hayessp.htm}
\item \textsuperscript{69} McVety, \textit{Enlightened Aid}, 376
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could follow America’s example in a dialectical process of technological development and democratic liberalization seemed logical. As McVety notes, the sanguine planners of the Truman administration failed to grasp the “possibility of a nation importing America’s economic and scientific advances while rejecting its political ones.”

Beyond ideology, conceptual finessing like Hayes’s was also a matter of political necessity. As outlined in Chapter 3, the White House found itself caught between an astoundingly expanded global responsibility on one hand, and the machinations of a recalcitrant band of skeptical politicians with domestically oriented, fiscally hawkish ideologies on the other. If Hayes’s designs seem blinkered, they nevertheless illustrate the growing discord between traditional domestic political narratives and the international strategies under consolidation by a growing foreign policy elite. The incoherence of the Point Four ideology was a natural expression of the contradictory impulses of the early postwar United States.

Point Four’s shortcomings were more than just rhetorical, however. The program’s fatal weakness was that it had been announced before anyone knew how the program would operate, how it would play out politically, or what it would really even do. As Stanley Andrews, the foreign relations chief of the USDA, noted, when Truman made his inaugural speech, “the State Department was caught flat footed. They didn’t have the faintest idea in terms of a program or anything else. So the bureaucracy began to debate on what in the hell this all means, and who would run it.”

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70 McVety, Enlightened Aid, 373
71 Oral history, Andrews with McKinzie, October 31, 1970.
That was if there was a program to run at all. Corporate interests lodged sharp opposition to the program as Truman had presented it, for three main reasons. First, businesses were unhappy at the prospect that the U.S. might be working through new multilateral bodies like the U.N. Second, most American corporations in the period looked warily on investment in developing countries in general, apprehensive as they were of leftism, political instability, and the recent spate of resource nationalization by anti-imperial governments. Finally, those businesses that had pursued activities in Asia, Africa, and Latin America insisted that the U.S. government’s role in global technological development be limited merely to protecting businesses operating overseas against financial losses. As Carroll Pursell noted, this was still a transitional era in which “business leaders, rather than economists or technologists, were the government’s main source of information and political pressure… Parochial American business interests rather than any real and informed concern for overseas development were paramount.” To deflect this pressure, the Point Four’s public relations team reoriented the program’s ostensible purview, emphasizing the boon it would provide for U.S. business, as well as the bulwark that a foreign technological program could provide against the spread of communism.

A voluminous State Department report delivered to Congress in July attempted to assuage fears that government diplomatic activity would supplant U.S. private high-tech industry in the world economy. While “‘dollar imperialism’ has no place in the program,” the introduction to the report

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72 Black, “Interior’s Exterior.”
assured, “fair and nondiscriminatory treatment will be sought for United States investors.”74 A technological diplomacy program would now not only avert the strategic security concern over the “ideological vulnerability” of less developed countries, but would also generate friendly trading partners with growing economies. Point Four, in other words, would “mean a long-term expanding market for the capital goods of western Europe and the United States.”75

Even Truman began to pitch Point Four in terms of the expansion of U.S. commerce. In his message urging Congress to approve the program, the president argued that the state of the postwar world presented a problem for American capitalism abroad, and that a drastic step leveraging U.S. technical ingenuity would be needed to fix it. “In view,” he argued, “of the present troubled condition of the world—the distortion of world trade, the shortage of dollars, and other after-effects of the war—the problem of substantially increasing the flow of American capital abroad presents serious difficulties.”76 Just as technology had helped the United States win the war, the nation now needed to use it to secure the global order for the sake of American capitalism.

It is worth noting that Point Four fit the pattern we have observed time and again in this period: the clash, that is, between a rising worldview that the U.S. occupied a new place in the world on one hand, and a conflicting set of prewar assumptions and impulses on the other. Although Truman did seek to assuage business concerns in describing a rosy global future for American capital, he also stressed that the state would henceforth represent an inextricable element in the propagation

75 Ibid., 3.
76 Ibid., 24.
of American power. As he argued, legislation for a technical assistance program was one of the “essential first steps in an undertaking which will call upon private enterprise and voluntary organizations in the United States, as well as the Government” toward the improvement of the economies of developing regions. What was new about Point Four was that the President was now articulating a process, one in which “technical assistance is necessary to lay the groundwork for productive investment. Investment, in turn, brings with it technical assistance.” Private initiative alone would no longer suffice; the task was now global in scope, and would require the state to lay the groundwork. Further, “in many of the areas concerned, technical assistance in improving sanitation, communications, or education is required to create conditions in which capital investment can be fruitful.”

Truman’s argument for the importance of the state was supported by a sweeping report for the White House produced by the International Development Advisory Board, headed by Nelson Rockefeller. After two years of study, the report concluded that “neither government agencies, nor private groups, nor international agencies, nor national agencies can do the job of international economic development alone. Each has its proper role and a highly important role. It is not a question of government versus private effort or international versus national effort. The task of the Overseas Economic Administration is to hitch all the horses into a single team.” This was an important pivot. While activities by and for private industry would remain important to the new

77 Ibid., 23.
initiative, government would now necessarily move beyond its previous role as mere guarantor or encourager.

As historians like Emily Rosenberg and Jenifer Van Vleck have shown, the American state had long pursued foreign objectives at arm’s length via schemes like chosen instrument policies and financial incentives.\(^7\) The bedrock concept behind Point Four, by contrast, was that government must wield American technological superiority first, before private industry could truly take advantage of growing global markets. In a time of unique instability in the world, the American state would be required to step in and seize the rudder of the global economy, as it had with the Marshall Plan and the World Bank. Thus, although foreign policymakers’ constant need to reassure the private sector that it would remain a key partner marked a historical continuity, we can also see clear evidence that a new ideology binding state initiative, technoscience, and global power was on the rise at the highest levels.

Nevertheless, as would be solidly true through 1957, the struggle to truly implant and enact that ideology was an uneven one, since the promises of American engagement with the developing world far outstripped the actual will or resources in Washington to do so. As Dean Acheson—who himself had always been lukewarm to the Point Four idea—wrote bluntly, “the hyperbole of the inaugural outran the provisions of the budget.”\(^8\)

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8 Acheson, *Present at the Creation*, 265.
This gulf between rhetoric and reality became a public relations problem almost immediately, as U.S. officials struggled to contain a spiral of excited global press on the new American technological push. As *Fortune* magazine put it at the time, the idea to use U.S. technological might and ‘know-how’ to improve global stability “hit the jackpot with the world’s emotions.”

It wasn’t just the press that got carried away. Truman’s ambitious rhetoric emboldened elites in developing countries to call for an even wider program. When Andrews met Pakistan’s economic director Said Hassan, for example, the two men signed a bilateral agreement, took official pictures, and then Hassan said, as Andrews recalled it, “Well, now that that’s done, let’s get down to business. Here are the projects we want financed… I want 10 million dollars for a sugar mill, and I want 13 million for a fertilizer plant,’ and right on down the line.” Part of the misunderstanding, Andrews thought, derived from the U.S. ambassador in Pakistan not understanding what Point Four was or how it worked. Similarly, Dr. Charles Malik of Lebanon drew on the Point Four rhetoric to propose an enormous intergovernmental “Marshall Plan” that would see developed countries distribute technological advancements to the rest of the world. This, of course, flew directly in the face of Samuel Hayes’s idea for the scheme. As Hayes noted, Point Four was in fact supposed to be a technological *countermove* to ideas like Malik’s—the whole point had been that “the U.S. can’t afford to get into a big program of providing financial resources of large dimensions. We can’t have a Marshall Plan for the rest of the world.”

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81 Cullather, *Hungry World*, 75.
83 Oral history interview, Hayes with McKinzie, July 16, 1975.
The State Department thus had to do damage control almost from the outset. Andrews explained to Hassan that “‘there’s been some mistake somewhere. If anybody has indicated to you that we have that kind of money it's just wrong.’ A very, very tense situation developed. We finally convinced him of what we were trying to do.”

Assistant Secretary of State Willard Thorp, meanwhile, went to the U.N. in February 1949 to explain awkwardly to the Economic and Social Council that the U.S. program would actually be modest and limited in scope. Just a month had passed since the fanfare of the program’s launch, with a world seeming to witness a new birth of American global engagement and technoscientific deployment. Yet it was already being reined in.

Industry groups at home, meanwhile, continued their offensive. While Acheson argued that Point Four would guarantee American security interests in a darkening world, the Chamber of Commerce, in line with the rising postwar libertarian techno-positivism that we saw in Chapter 2, scolded that “private industry has the industrial know-how. Government has not. The most effective assistance in industrial development abroad can be provided by skilled technicians of American corporations which are investing their funds.” The Foreign Trade Council demanded that “in all but a few fields,” technical assistance should be provided by private investors. In the face of this onslaught of lobbying, administration officials could only weakly fight back that, in fact, the government did

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85 Acheson, Present at the Creation, 265.
86 Pursell, Technology in Postwar America, 48
possess considerable expertise in critical fields like public health, agriculture, administration, and education.\textsuperscript{87}

Under this withering pressure, and with Acheson’s State Department proffering only lukewarm support, Congress dragged its feet. In order to sell the bill enacting Point Four, the White House continued its strategy of foregrounding the benefits to American commerce and private industry that technical aid would render back home. The administration promised businesses special tax allowances, government-backed indemnity from war and expropriation in host countries, and free technical assistance to set up their activities abroad.\textsuperscript{88} In a June plea to Congress, Truman wrote that “to increase the output and the national income of the less-developed regions is to increase our own economic stability.”\textsuperscript{89} Through these pledges and compromises, the Act for International Development increasingly became a bill to lubricate the machinery of U.S. private capital in the world, and decreasingly one modeled after the Tennessee Valley Authority and the Office for Inter-American Affairs’s philanthropic programs.\textsuperscript{90} As the Ford Motor Company saw it, “foreign investment—not technical assistance—is really the crux of Point Four.”\textsuperscript{91}

The program finally passed as part of the Foreign Economic Assistance Act of 1950, but its appropriation hardly represented anything approaching a ‘Marshall Plan for the world.’ The entire

\textsuperscript{87} Memorandum, “Legislative Background of Point Four Program,” June 20, 1950, Department of State. Foreign Relations of the United States, 1950, National Security Affairs; Foreign Economic Policy vol. 1, A/MS Files, Lot 54D291, Drawer 21, digitized, https://history.state.gov/historicaldocuments/frus1950v01/d304
\textsuperscript{88} House Committee on Foreign Affairs, “Point Four,” 1949, p.24.
\textsuperscript{89} House Committee on Foreign Affairs, “Point Four,” 1949, p.24.
\textsuperscript{90} Macekura, ”The Point Four Program,” 2013.
\textsuperscript{91} Paterson, “Foreign Aid under Wraps,” 125.
initial aid package, in fact, came to only $35.5 million, to be spread across nearly four dozen countries. But what the scheme lacked in resources, its supporters hoped, could be made up in expertise. This view was given a boost when Dr. Henry G. Bennett, the longtime president of Oklahoma Agricultural and Mechanical College, was put in charge of the program. This appointment at least gave the State Department confidence that the experience and lessons that had been accumulated by three decades at the Agricultural Extension Service could be propagated abroad. Only a year later, however, Bennett and his wife were killed in an air crash in Iran while on assignment for Point Four. Bennett’s death, in Acheson’s words, “dimmed [Point Four’s] prospect. Although the program continued to do a creditable job, it remained the Cinderella of the foreign aid family.” That the tragic loss of one administrator could ruinously weaken what was a supposedly ambitious global technology scheme demonstrates the feebleness of the program in general.

Abroad, Point Four’s ambition was checked by changes on the ground. Nowhere was this instability more pronounced than in East Asia. At the beginning, technoscience champions tried to promulgate a vision for international audiences that eschewed the pro-business compromises of the domestic debates, hewing instead to the program’s original ideology of partnership and uplift. Speaking through Voice of America to the students of Korea after a year of war, for example, Vannevar Bush declared that science and technology represented a path for the country to rise from the ruins of Japanese and communist subjugation. Korean engineers, he told them, would work with

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92 Memorandum, “Legislative Background of Point Four Program.”
93 Acheson, Present at the Creation, 266. Benjamin Hardy—the originator of the Point Four plan, now serving as the Chief Public Affairs Officer for the Technical Cooperation Administration—was aboard the same aircraft, and was also killed.
their benevolent foreign counterparts to build the dams, railroads, airplanes, ships, and agricultural innovations that would allow the country to “recover from the cruel ravages of war.”

But if Korea was to receive the fruits of U.S. technological diplomacy, it was not going to come through Point Four, despite that program supposedly being the primary conduit for the peaceful deployment of American technoscientific patronage. Nor would the program bring significant technical aid across the Yellow Sea, as had also been intended: In a last-ditch attempt to ward off a Communist takeover, Point Four in China’s Yangtze Valley was converted into an effort at land reform. So strategically attractive was this transformation that the Department of State and USDA soon informed the UN that “a world-wide land reform” program would now be America’s top strategic priority. Money, previously so hard to come by, suddenly became available—Point Four’s $35 million appropriation skyrocketed to $211 million. Technoscientific uplift had met its match in the mushrooming doctrine of containment.

Perhaps the most striking of these strategic reorientations was in Vietnam. There, U.S. aid money had initially been put towards building up a police force for the newly installed provisional president, Ngo Dinh Diem. Roughly $300 million in loans were then approved for development programs, to be dedicated to rice and other agriculture, streamlining infrastructure, and education and resettlement schemes. According to Andrews, however, the money began being recommitted in suspect ways, like building roads—among them Highway 19 (from Saigon to the central highlands).

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94 Vannevar Bush, “Message to be broadcast to Korean Students,” Voice of America, State Department, September 12, 1951. Vannevar Bush papers, box 133, LoC.
95 Cullather, *Hungry World*, 97
and Highway 1 (to the Chinese border)—along with new airfields and harbors. In Andrews’s words, “the idea was that you could run tanks over those roads. Those roads cost an average of 50 million dollars apiece. In the meantime, they were building harbors that would take ships three times as big as what was needed there. And they were building airfields up in the interior there that would take a B-52 bomber. This was a time when we were supposed to be helping the people, but all the money was drained off into those things which were really preparing for a war.”

As Megan Black has argued, other agencies, including the Interior Department and the Defense Materials Procurement Agency, began to co-opt Point Four for their own purposes. Technicians from these agencies assisted private companies in siphoning coal, copper, iron, lead, chrome, manganese, petroleum, and other “strategic materials needed by the free world” from impoverished Point Four countries. The government performed much of the infrastructural preparations, private companies performed the work, and resources vital to the manufacture of American arms and consumer goods were funneled back to the U.S. The program had strayed far from the vision of helping developing countries “realize their aspirations for a better life,” as Truman had articulated in his inaugural.

Point Four continued to limp along, but its myriad contradictions and lack of full high-level support torpedoed its chances for success. The program’s management remained fragmented between warring Washington bureaucracies (among them the State Department, the quasi-separate Technical Cooperation Administration, and the Institute for Inter-American Affairs) for more than a

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98 Megan Black, “Interior’s Exterior.”
year after its activities got underway. It also suffered from crippling procedural delays and woefully inadequate staffing for key leadership positions. Point Four field operations were piecemeal at best, which resulted not only in a lack of any cogent “country projects” of any kind, but also a lack of leaders with any real responsibility to develop them.99

It was arrival of the Eisenhower administration that ultimately sounded the death knell for what had originally been an ambitious attempt to leverage American technology for peaceful diplomatic ends. The new president was ardent in his belief that “chronic underdevelopment” could not be cured with American money, and his conviction was echoed by a Congress which, in a newly bellicose environment, refused to send assistance to nations not steadfastly aligned with the Western bloc.100 In June 1953, the Technical Cooperation Administration—Point Four’s umbrella agency—merged with the military-focused Mutual Security Agency, which solidified Point Four’s role as a mere conduit for strategic raw materials.101

Any exuberance for technological aid or foreign technical capital assistance that may have endured from the late 1940s appeared to have well and truly lapsed by January 1954. In that month, Eisenhower’s Commission on Foreign Economic Policy, headed by industrialist and White House advisor Clarence Randall, recommended the discontinuation of all capital aid related to technological assistance unless it could be rendered strictly on a loan basis. Although the Randall Commission

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100 Cullather, Hungry World, 137.

reaffirmed the desirability of multilateral technical assistance programs, the sapping of their capital components rendered any long-term attempts at technology-based reform untenable.

Development would be back, and the doctrine of global stability underlying it remained a constant preoccupation among U.S. leaders in the coming years. But as the nation’s first foray into a major technical assistance scheme in the developing world, Point Four was stillborn. The disinterest of Congress, the opposition of powerful multinational corporations, the complications of ‘hot’ war, the myopia of the program’s administrators, and the blurriness of its ideological underpinnings, all conspired to torpedo its idealistic intentions. Point Four represented in microcosm the lack of readiness of the American state for a nimble pivot toward both massive global engagement and coherent techno-diplomatic deployment. Assuring global stability in the new age of U.S. hegemony looked much easier on paper and in White House memoranda than it did across the oceans.

The Big Chill: A ‘Paper Curtain’ Descends across the Continent

If Point Four saw the designs of civil servants and development thinkers thwarted by the vagaries of politics and misdirected priorities, then it is equally important to consider the frustrations of the designs being expounded by scientists themselves.

For decades, the science community had attempted to promulgate an idealistic paradigm of scientific internationalism predicated on what Joseph Manzione calls “a set of ecumenical traditions and ideals common to the scientific profession.” Among these were that “the methods and practice of science must remain unaffected by culture or politics, that unrestricted scientific exchange among
professionals of all nations or peoples was critical to the progress of science and human civilization, and that science itself was a kind of *lingua franca* that promoted a cosmopolitan perspective, unified goals, and an order based on merit that crossed international boundaries.”

These ideals met their match in the geopolitical maelstrom of the Cold War. Scientific internationalism was quickly warped to conform to the Manichean power politics of the moment, and concerns of national security and global preeminence gradually led to the mutation of researchers’ worldviews and institutional obligations. Even still, many policymakers and politicians in the United States viewed the scientific profession with suspicion and even contempt, with the result that the early Cold War produced significant efforts to police the practice of science via stifling security procedures and restrictions.

Historians have produced voluminous and excellent scholarship confirming and contextualizing many of these assertions. My purpose here is not to rehash the historiography on science and the security apparatus in the Cold War. Rather, I would instead like to frame those dynamics in the context of what they might tell us about the implantation of the ideology equating science and technology with global power.

At the most basic level, the atomic bomb frightened people, and so the rising frenzy of anticommunism—as well as high-profile atomic spy scandals like that of Klaus Fuchs and the Cambridge Five—led to a concentrated security focus against the producers of that power, the scientists. That much is obvious. But if we look beyond the dynamic of atomic fear, we can also see a

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102 Manzione, “Amazing and Amusing,” 13
103 See the literature review in this dissertation’s introduction.
growing expression—even among McCarthyites—of a notion that the U.S. possessed innate technological gifts that must be protected in order to ensure the nation’s primacy in the world. As such, we must look at the scientific security scandals of the 1940s and 50s as part of a broader evolution of a new view of American power.

This vision and the practices it fueled were deeply paradoxical. Ignoring decades of Vannevar Bush-like pleas that science was an inherently open and internationalist endeavor, security officials and security-minded legislators attempted to bottle and quarantine something they considered to be an American proprietary advantage in the postwar world. Of course, the effect of their character assassinations, security hearings, background checks, visa denials, and intelligence investigations was to isolate—to some extent, although scientists often exaggerated the degree—American research and development, as well as to cause a ‘chilling effect’ on the peaceful foreign policy expressions of U.S. technoscience. But therein lay the paradox—the harm caused by years of a deliberate imposition of security obstacles actually represented an acceptance of the technoscientific formulation of U.S. power. It just willfully ignored the expertise of the purveyors of that power itself.

The following section will trace that paradox from the security case of the physicist Edward Condon to the attempts to hamstring the activities of the National Science Foundation via security regulations, a circumstance that saw technoscience champions expressing alarm about the loss of U.S. power by 1957. Together, these cases illustrate the contradictory impulses of a nation coming to grips with the sources of its new hegemony, as opposing interests clumsily attempted to wedge their understandings of those sources into prevailing and evolving political paradigms.
The tug-of-war over allowing science into the inner workings of the policymaking apparatus began well before Joseph McCarthy’s rise to infamy. One of the early watershed cases was that of Bureau of Standards director Edward Condon, a physicist who had been a key figure during the war in both Radlab and the Lawrence Laboratory. Condon was a moderate internationalist who had a then-mainstream vision of multilateral nuclear control, and who believed in the value of open basic research across borders. Despite his record on the Manhattan Project being unimpeachable, Condon became the subject of a smear campaign by the House Un-American Activities Committee (HUAC), which leaked doctored letters to the press suggesting the scientist was a traitor.104

Condon’s case gives a clear sense of how early the anticommunists’ rhetoric conflated technology with security. In March 1948, HUAC issued a brutal report on Condon, suggesting he was among a group of “Government officials in strategic positions who are playing Stalin’s game to the detriment of the United States.” Accusing him of using his leadership of the Bureau of Standards to recruit scientists to a subversive Soviet front group, as well as noting the “dangerous extremes to which Dr. Condon has gone in an effort to cooperate with communist forces in the United States” and to “dissipate our atomic bomb ‘know-how,’” the committee demanded that the President fire

him, as well as take action to prevent other Condons from undermining the nation’s technological security.\textsuperscript{105}

The science community howled that HUAC’s politics of insinuation and the presumption of guilt would deter willing scientists from respecting government work, an outcome from which “our country will have suffered incalculable harm.”\textsuperscript{106} Eminent members of the American Academy of Arts and Sciences took the same tack, noting that the persecution of government scientists and the suggestion that sharing research internationally represented disloyalty could “only result in a reluctance on the part of reputable scientists to take government positions, at a time when effective government science is of the greatest importance to welfare of the country.”\textsuperscript{107}

Of course, pushback from scientists was to be expected, particularly at this early stage when progressive leftism from the profession was still commonplace in the public discourse. Their arguments, however, were bolstered by national political leaders. In September 1948, President Truman addressed the American Association for the Advancement of Science and did not mince his words. “There are some politicians,” he said, “who are under the impression that scientific knowledge belongs only to them. The rumor has come to me that one of them even made the remark as to why we let the scientists know anything about the atomic bomb.” An atmosphere of rumors, gossip, and

\textsuperscript{105} J. Parnell Thomas, Richard B. Vail, John S. Wood, House of Representatives, “Report of the Full Committee of the Special Sub-Committee on National Security of the Committee on Un-American Activities,” Vannevar Bush papers, box 81, LoC.

\textsuperscript{106} “A Statement by Members of the National Academy of Sciences Concerning A National Danger,” March 26, 1948. Vannevar Bush papers, box 81, LoC.

\textsuperscript{107} “To the Fellows of the American Academy of Arts and Sciences,” April 5, 1948, Vannevar Bush papers, box 81, LoC.
vilification, he argued, undermined the research upon which “American scientific leadership and true national security” depended. It represented, the President believed, “the most un-American thing we have to contend with today.” This was an unprecedented show of support for scientists, grounded in the increasingly salient notion that if science and technology were power, then witchhunts that sapped their dynamism would only harm the national interest.

It is important to note that Truman was framing his opposition to HUAC’s smear tactics explicitly in terms of the importance of the campaign’s victims to national strength in a new world order. “Sober recognition of scientific research as the basis of our future national security should certainly be non-partisan,” he declared, for which reason “all Americans have a solemn obligation to avoid those methods and procedures which are impeding scientific research.” Condemning attacks on science by “men with other axes to grind and red herrings to drag around” was protection of America’s place in the world itself.

David Lilienthal, now the head of the Atomic Energy Commission, agreed. Naturally, Lilienthal’s primary concern was with the detrimental effects of the witchhunts on atomic energy research, but he, too, was careful to frame the issue in the language of American power more broadly. The nation’s technological strength was not a product of some inherent trait or the work of individual geniuses, he noted, but was rather a precious resource requiring extensive public commitment, something directly threatened by actions like that of HUAC. “America’s leadership in

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108 Address, Harry Truman to American Association for the Advancement of Science, Washington, D.C., September 13, 1948, reprinted in Bulletin of the Atomic Scientists vol. 4, no. 10 (October 1948).
109 Ibid.
this new and fateful field of knowledge requires a stupendous effort,” he noted. “The notion that our
atomic energy leadership depends on a ‘secret formula,’ locked in a vault, is nothing less than a
gigantic hoax upon the people this country. Our leadership depends on developing new knowledge,
and the new applications of that knowledge.” The basis of global power was therefore simple: “Our
position in the world… requires that we know more and more, and that we know it first.”

Condon’s name was eventually cleared and he took a position in the private sector, but the
chilling effect on progressive and open research in the state context had only just begun. Just before
the enactment of the National Science Foundation legislation in April 1950, Southern Democrat
Howard W. Smith introduced an amendment to it stipulating that no government contract or
support for research would be permitted until the FBI had conducted a thorough investigation of the
researcher. Even the appointment to the Foundation’s directorship of Alan Waterman—a
decorated civil servant and the deputy director of the Office of Naval Research—was held up, as
investigators probed why his wife, Mary, had once gone to a party at the Soviet embassy. Only
personal intervention by Harvard’s James Conant to the White House managed to get Waterman
cleared.

Security meddling in the NSF—the foundation that was supposed to be the consummation of
the idealistic tenets of *Science: The Endless Frontier*—was particularly galling to scientists. As Sam

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110 Ibid.
111 “Proposed Amendment to the National Science Foundation Bill,” 1950, box 87, Vannevar Bush papers, LoC. The
amendment also applied to agency employees, and also required them to sign an affidavit swearing allegiance to the
US and foreshewing any subversive causes.
112 Oral history interview, Charles F. Brown, with J. Merton England, August 1, 1975, RG307, 4 - NSF Historian file,
entry UP-UP-1, stack 103, row 37, cpt 15, container 44, NARA.
Goudsmit, the distinguished head of physics at Brookhaven National Laboratory, wrote privately, the Smith amendments were “horrible. Pretty soon bachelor’s degrees will be awarded by the F.B.I., instead of by the various universities.”\textsuperscript{113} As the science community was quick to point out, the concept of loyalty tests for basic research was illogical, since the results would be shared openly anyway and would benefit the United States regardless.\textsuperscript{114} As articulated by a forceful letter to the Senate from an animated Harvard Physics Department, heavy-handed attempts to root out the very rare disloyal applicant were not only antidemocratic and uneconomical, but would be highly damaging overall to the morale of researchers, since they would create an atmosphere of paranoia about which topics could and could not be discussed, and confusion about what was secret and what was not. If scientists were obliged to second-guess their own work in this technoscientific age, then national security itself would be under threat.\textsuperscript{115}

It is important to reflect on the changing nature of the arguments of policy elites and scientists in defending an ideology of research as a geopolitical tool for the United States. Just as arguments during and immediately after the war tended to emphasize industrial well-being and technical benefits accruing to the common person, by the end of the 1940s and beyond, debates such

\textsuperscript{113} Letter, S.A. Goudsmit to Vannevar Bush, March 2, 1950. Vannevar Bush papers, box 87, LoC.

\textsuperscript{114} For more on this question vis-à-vis the popular and political conceptions of “basic” and “applied” science as discussed in Chapter 3, see Mario Daniels and John Krige, "Beyond the Reach of Regulation?: ‘Basic’ and ‘Applied’ Research in the Early Cold War United States," \textit{Technology and Culture} 59:2 (April 2018). As Daniels and Krige put it, “‘basic science’ was to be open; ‘applied science’ could be subject to regulation and classification if the circulation of its results appeared to endanger national security. To many of the actors involved it was quite clear that this binary logic was at loggerheads with the ambivalences of scientific as well as security practices. Yet this was of secondary concern, because at its heart the demarcation was defined along political rather than epistemological lines.”

\textsuperscript{115} Telegram, Harvard Physics Department to Honorable Elbert D. Thomas et al, March 28, 1950, box 87, Vannevar Bush papers, LoC.
as that roiling over the suppression of open research for security purposes began to explicitly position the United States globally, employing a new language of world leadership and the risks of “falling behind.”

Sam Goudsmit himself provides an instructional example. In an essay in the journal Research in 1949, he presented a clearer-eyed vision than many of his colleagues, noting that the idealized notion of scientists living in a bubble of isolated curiosity—as Science: The Endless Frontier had tried to preserve—had become a chimera. R&D now had such a “far reaching effect upon all of our lives [that] it is, therefore, a natural development that in turn the outside world tends to control the course of research, that it makes demands upon science.” Although Goudsmit’s ultimate point was similar Bush’s—that freedom of inquiry produced the best science—his ultimate tool of persuasion was national and geopolitical in nature. With sober-eyed recognition of the new role his discipline had come to play in world affairs, Goudsmit signaled that “the results of research and the special aptitudes of trained scientists have only recently been recognized as playing an important role in the progress of civilization… The potential strength of an empire, as well as its material welfare, may be closely linked to the quality and productivity of its scientists. As a result, scientific investigation has lost much of its carefree independence.” An American scientist in a major trade journal speaking of research in imperial terms represented a sea-change from the paradigm that had prevailed before the Second World War.

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Of course, it was precisely because science and technology were now being broadly viewed in imperial terms—as well as in the proprietary language of ‘stockpiles’ and ‘reserves’—that policymakers and bureaucrats with little knowledge of the process of research now flailed to protect it, endeavoring to create figurative Hadrian’s Walls at the boundaries of the new scientific empire, no matter the protestations of scientists themselves.

By 1952, both the tendency toward secrecy and the scientific backlash against it were being argued firmly in terms of global power. The debate reached a particular flashpoint with the passage of the controversial Immigration and Nationality Act, sponsored by Democrats Pat McCarran and Francis Walter, which passed over the angry veto of Truman. The Act consummated the exclusionary and discriminatory practices put into place by the Internal Security Act of 1950, and provided for strict national quotas, stringent loyalty procedures, and quick-trigger detentions and deportations. In terms of science and technology, the rules under Section 203(a) of the new bill forced any researcher seeking resident alien status in the U.S.—or, indeed, wishing to perform any work for money at all—into the same nationality-based quotas as other professions. The quotas themselves were, astoundingly, based on the number of persons from each country of origin who were in the United States as of the census of 1920. The act exempted a handful of vocations from this limitation—religious ministers, for example—but left scientists to compete with every other applicant from their home countries.117 In his veto message, Truman railed in vain against this retrograde, antiquated worldview, decrying “the absurdity, the cruelty of carrying over into this year of 1952 the isolationist

117 Charles Glour to Vannevar Bush, October 14, 1952, box 93, Vannevar Bush papers, box 93, LoC.
limitations of our 1924 law.” As Truman noted, the political assumptions of a past United States were no longer commensurate with the nation’s new global role, and the quota system based on that archaic mode of thought was “long since out of date and more than ever unrealistic in the face of present world conditions.”

Truman was not alone in inveighing against the new restrictions, nor in appealing to world conditions to do so. Scientists, too, framed their arguments in the language of America’s position vis-à-vis the research establishments, scientific capabilities, and technological might of other global powers. These were conscious attempts to awaken policy elites to the dangers that myopic security obstacles were wreaking on a central component of American strength in the world. As Vannevar Bush testified to the President’s Commission on Immigration and Naturalization, applying racial or national quotas to scientists was not only illogical, but flew in the face of the profession’s new centrality to U.S. power. Himself a conservative, Bush argued that “our search for highly competent scientists, and our feeling that they would add to our strength and standing as a nation, is quite a different thing from our problem of the admission of immigrants generally.”

It is crucial to reiterate that one of the primary boons of the Tizard Mission had been not only the dazzling technologies brought by the British, but also the presence of experienced British researchers themselves, people who could perform hands-on organization and collaboration with

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their American counterparts.\footnote{For more on the movement of “knowledgeable bodies,” see Mario Daniels, “Restricting the Transnational Movement of ‘Knowledgeable Bodies’: The Interplay of U.S. Visa Restrictions and Export Controls in the Cold War,” in Krige, ed., How Knowledge Moves.} American scientists attempting to continue this liberal internationalist collaboration and to import foreign researchers—and, in the process, to gain foreign knowledge for the benefit of U.S. institutions—now found themselves thwarted by the 1948 United States Informational Exchange and Education Act, which allowed foreign scientists to enter the country only on a strictly reciprocal and non-remunerative basis.\footnote{Glour to Bush, October 14, 1952, LoC.} Anything beyond that—and anything that paid the visitors for their trouble—was next to impossible.

The Berkner Report had warned two years previously of the ongoing harm that immigration requirements were inflicting upon U.S. power. As evidence, it recounted a damming episode in which an eminent British scientist was subjected to clearance procedures so onerous and lengthy that in the end he simply gave up his attempts to visit or provide any direct benefit to U.S. science. The unnamed British scholar was “conservatively estimated to be fully two years ahead of his American colleagues with respect to his field,” reported Berkner, meaning that “his visit was largely an opportunity in which American science had everything to gain with little to return.” Continuation of constraints like these, Berkner surmised, would only bring diplomatic embarrassment and, eventually, total discouragement among foreign scientists from the desire to interface with Americans. More bluntly, it would also simply waste American researchers’ time and resources as they repeated experiments that had already been done abroad. American scientists would be “deprived of the
opportunity of making a two-year forward step in their work,” while any money spent on them would “represent the subsidization of an inferior effort.”

On October 13, 1952, thirty-four eminent physicists took a stand, publishing a 51-page special issue of the Bulletin of the Atomic Scientists condemning the “stifling” American visa policy. Among its contributors were Albert Einstein, Harold Urey, Arthur Compton, Victor Wiesskopf, and Michael Polanyi. The publication was edited by University of Chicago social scientist Edward A. Shils, whose introductory editorial categorized the security restrictions against scientists as a “Paper Curtain” descending across American shores. Shils cut directly to the heart of both the contradictory way the federal government was unfolding its new bureaucracies, and the self-destructive policies that thwarted it from effectively managing the nation’s new global responsibilities. The United States, he wrote, was “undoing with one hand what they are so laboriously and expensively accomplishing with the other.” While one segment of leaders “generously and farsightedly has sought to defend the free societies of the West through the Marshall Plan, the North Atlantic Treaty, and other measures,” security and immigration obsessions were at the same time stifling the progress of science, scholarship, and education, thus serving to “alienate our allies, comfort our enemies, enfeeble our free institutions and traduce the principles of liberty.” Notably, this argument put scientific activity explicitly in the same terms as the Marshall Plan and NATO as a crucial element of U.S. foreign policy. Anyone concerned with the ability of the U.S. to direct the world order through international

122 American Department, Foreign Office, “The Role of the State Department in Science,” July 12, 1950, FO 371/81768, UKNA.
and global forms of political and economic governance, in other words, should be just as concerned about the way it was walling itself off from the developments of foreign science.

One of the Bulletin’s gambits was to emphasize a phenomenon that technoscience luminaries had been desperately trying to alert policymakers to for several years: The dozens of cases of foreign scientists being denied entry, deported, or otherwise discouraged from aiding the national interest as a result of the blinkered impositions of those in government possessing less—or, perhaps, less knowledgeable—interest in the progress of science and technology. The Berkner Report’s story on the failure to take advantage of an eminent British scientist was just the tip of the iceberg: The Bulletin added 26 other case studies of world-class researchers who were either denied visas or put through prohibitively onerous clearance procedures which prevented them not only from attending conferences and interchanges in the United States, but also from researching and teaching there to the benefit of U.S. colleagues and students.124

Among the more noteworthy was the case of Rudolph Peierls, one half of the authorship duo of the bombshell Frisch-Peierls Memorandum, which the British had used to alert the Americans to the possibility of nuclear weaponry in the early days of World War II.125 Either through suspicion or incompetence, the State Department denied and delayed Peierls’s 1952 application for a visa to attend an open atomic conference at the University of Chicago. Remarkably, this heavy-handedness over an unclassified conference persisted while Peierls was in the United States anyway, using his British

124 Ibid.

125 For more on the memorandum and its reception, see the Marcus Oliphant episode in this dissertation’s Chapter One.
diplomatic passport for a series of conferences and meetings on highly classified nuclear energy information, enjoying full access to their data.\textsuperscript{126}

More telling was the case of Marcus Oliphant, the British-Australian scientist who had waged a personal campaign to convince U.S. officials to accelerate the program that would become the Manhattan Project—the man who, in the view of Leo Szilard, should have been the first to receive from the United States a “special medal [to] meddling foreigners for distinguished services” for his extraordinary effort.\textsuperscript{127} In 1952, Oliphant received a sponsored invitation to the same Chicago conference as Peierls. Upon accepting, he was assured by the Canberra embassy that visas for he and his wife would be issued nearly immediately. The State Department, however, mysteriously stonewalled, and the visa never came. Oliphant inquired repeatedly for months as to his status, but State officials refused to answer his entreaties, until he was forced to cancel all bookings and abandon the trip.\textsuperscript{128}

Oliphant’s sympathizers suspected that the State Department’s action was retaliation for his open criticism of American policy on international control of atomic energy, a position common among progressive scientists at the time. A \textit{Daily Express} inquiry suggested that American security officials likely knew Oliphant possessed no subversive views, but that his critiques had nevertheless “given Communists bullets to fire.” Of course, an outright denial of entry for a scientist of Oliphant’s caliber—especially one who, in his own understated words, had “been of some help to the United

\textsuperscript{127} Rhodes, \textit{The Making of the Atomic Bomb}, 372.
States” in the fields of radar and atomic energy—would have been a diplomatic embarrassment, and thus the State Department’s strategy appears to have been to feign “administrative delays” indefinitely until Oliphant gave up. Even foreigners who had demonstrably worked to lift the U.S. to its present position of technological leadership, it seemed, were not beyond rebuke.

Oliphant, Peierls, Condon—the pattern of leaving those who had helped build the United States’s present hegemonic capacity outside the gates was striking. The most infamous such case, of course, was the persecution of J. Robert Oppenheimer, the father of atomic weaponry who was subsequently tormented by the FBI, interrogated by HUAC, and denied access to atomic secrets. Scholars have written exhaustively of the context and ramifications of the Oppenheimer episode, but for our purposes it suffices to note that the case represented perhaps the knockout blow toward the country’s collective amnesia regarding the origins of American technological power. Together, the persecution of scientists and the attempted construction of a moat around supposedly sacrosanct American ‘know-how’ further engrained the notion that World War II had been a consummation of American genius, rather than the historical pivot it was; a fulfillment of innate potential, that is, rather than an unprecedented application of work in the arenas of statebuilding and global engagement.

129 Ibid.
The Oppenheimer affair gave technoscience champions an explosive means to try to awaken the public to precisely this misunderstanding. Vannevar Bush, for one, took the pages of *Newsweek* to write that the public-private collaboration behind U.S. scientific and technological power had emerged “during the second world war, [when] an effective partnership was gradually developed. Recently this partnership has been seriously damaged and is being gradually destroyed.” The stakes were no less than the forfeiture of the Cold War. “We are in a scientific and technological race,” he declared, and “unless we keep moving on apace, the Russians may get ahead of us. We cannot keep ahead without the full use of our scientific talent.”  

Separately, Bush lamented that government attempts to deploy scientists had become marred by a clearance system “which seems almost calculated to destroy their reputations by innuendo and charges based on spite.” On one hand, science and technology, by their natures, tended towards international engagement in a way that was traditionally alien to prewar American sensibilities; on the other, they also now occupied the center of what Americans considered to be the source of their most precious national secrets. This ruinous combination meant that scientists represented the single sector most devastated by the “hysterical witch hunt” of the era, but also that, paradoxically, “there is no place where it could be more disastrous to our national interest.” While Russians respected and exalted their scientists, Bush complained, Americans attacked theirs, ruining the reputations of individuals, destroying the appeal of the profession to brilliant young minds, and sapping the willingness and ability of eminent foreign researchers to lend their knowledge to the American cause.

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Scientists and technicians “yearn for a leadership in this country which would restore the old atmosphere in which there was a close knit bond of mutual confidence and respect between them and the military.”\textsuperscript{132} Although Bush didn’t articulate it, that yearning was for the brief window in which the incubation of a comprehensive state R&D complex had been an open political reality, one that had fostered the pivot towards technoscience in the first place.

In some cases, the security chill was not even a question of McCarthyism, but rather simply the result of incompetence or a misappropriation of bureaucratic priorities. Illustrative of this was the case of Charles A. Kraus, the inventor of ethyl gasoline and a Manhattan Project consultant who stayed on after the war to lend his expertise to the AEC’s Oak Ridge facility. Kraus became exasperated by the proliferation of increasingly voluminous security questionnaires that seemed to follow every general ‘tightening up’ of security in the political sphere. By 1953 the incessant demand to fill out lengthy and probing background information forms—which, in large part, simply duplicated past ones verbatim—drove Kraus to terminate his contract and withdraw his consultancy. As he noted, “it would have taken me a month of research to fill it out. I just it mailed it back to them and said it wasn’t worth the candle.” One of Kraus’s colleagues at Brown University, Carl W. Miller, had a similarly frustrating experience. A prominent scientist who had performed extensive top-secret work for the government during the war, Miller was assigned to be the head of research for a secret harbor defense project, but he encountered delays with his security clearance. This turned out not to

\textsuperscript{132} Address, Vannevar Bush, “Science and Progress?,” American Association for the Advancement of Science, Berkeley, Calif., December 30, 1954. Vannevar Bush papers, box 136, LoC.
be just a temporary setback—astoundingly, security officials failed to process his authorization for secret work before the whole project ended, two years later.¹³³

Nor were bureaucratic entanglements frustrating only to domestic scientists. International researchers frequently met a similar crimson tide of American red tape and red baiting, to the alarm of the U.S. scholars who invited them to the country. There was the case of Arpad I. Csapo, widely considered to be the world’s foremost expert in the chemistry of muscles, who was offered a professorship at Johns Hopkins University. Because he had been unwillingly drafted into the Hungarian army during the war, and because that organization was under a blanket, all-encompassing classification as an indirect “branch or affiliate of the Nazi Party” by U.S. immigration authorities, Csapo was considered an exponent of totalitarianism and denied a visa, forcing him to fight for it in court over two arduous years.¹³⁴ Then there was the case of heavily-published Japanese nuclear scientist Minoru Umezawa, whose visa was flatly denied by the State Department. Attempts by the distinguished University of Tokyo professor Takahiko Yamanouchi to intervene by appealing to the National Science Foundation on Umezawa’s behalf were met with the apologetic explanation that civilian science officials—even up to the level of agency director Alan Waterman himself—were powerless to intervene against the weight of the State Department and the national security apparatus. Ultimately, Umezawa ended up at the Centre de Recherches Nucléaires in Strasbourg. His American visa denial “caused considerable consternation among various scientific groups in Japan,” but the


¹³⁴ Statement, Vannevar Bush, to the President’s Commission on Immigration and Naturalization, October 29, 1952, Vannevar Bush papers, box 182; and Glour to Bush, October 14, 1952, LoC.
case sent the clear signal that American state-science leaders still represented a second-class community in the eyes of many security officials.\(^{135}\)

Of course, these cases tell us much about the ideology of technoscience in this period beyond merely the effect on scientists’ political mobilization or the frenzy of the Red Scare. MIT Corporation president Karl Compton, reflecting on his experiences in the NDRC during the war, cut to the heart of the matter when he professed that U.S. technological power—as the war and British exchange had proven so dramatically—lay overall in “its capacity quickly to seize upon a useful new idea or invention and reduce it to the practical terms of production and use on a large scale,” just as it had done with radar. American national security, therefore, could only “be advanced by such policies as will bring to our attention quickly and fully any scientific discoveries or inventions from any part of the world in order that we may proceed with the rapid development and production and use of those things which are most vital.” An insistence on clinging to the idea that security would be best served by “elaborate secrecy” and the maintenance of roadblocks to exchange was not only pointlessly “ostrich-like,” but was preventing the natural dynamics of give-and-take required to incentivize foreigners to loop the U.S. into the latest advancements. “[No] well informed person,” Compton declared, “would say that the U.S. has anything like a monopoly in the production of new ideas or scientific discovery.”\(^{136}\)

\(^{135}\) Diary note, Neil Carothers, “Telephone Conversation with Professor Townes of Columbia University Regarding Visa Difficulties of Minoru Umezawa,” January 4, 1954, Alan Waterman papers, box 1, LoC.

\(^{136}\) Letter, Karl Compton to Vannevar Bush, February 11, 1953, Vannevar Bush papers, box 26, LoC.
The chilling effect on U.S. research, that is, was not just a result of anticommunism or the co-optation of scientific political activity by the national security state, nor even of the failure by policy elites to recognize the importance of science and technology. It was, rather, the product of a warping of the nascent technoscience ideology itself—a basic misunderstanding on the part of an influential enough portion of those elites who had awakened to some degree to the power of science and technology of just how the U.S. had reached the point it had. The combination of industrial self-promotion, atomic paranoia, amnesia over the wartime exchange, and myopia over how the federal bureaucracy could continue to foster world-leading research, solidified the notion that a moat needed to be built around this twentieth-century outgrowth of innate ‘Yankee ingenuity.’ The U.S. had achieved incredible successes through the acquisition and improvement of concepts from other states’ R&D complexes, but with the stakes newly high in the early Cold War, many Americans had become convinced of the opposite—that the nation had inherent gifts that were vulnerable to subversion or theft at any moment. They therefore had to be kept under lock and key, no matter the actual effect on the process of scientific development, and no matter that the U.S. had been at its most successful when serving as a dramatically effective incubator for foreign science.

Arbitrary and unpredictable security procedures continued for most of the decade. As 1954 turned to 1955 and the worst of the Red Scare subsided, the NSF still complained to the Bureau of the Budget that security heavy-handedness was putting potential employees and contractors on ice for months—even as long as a year—while each individual case was reviewed. A scientist could scarcely be blamed, the Foundation said, if he or she declined to participate in any government-related
research whatsoever, an eventuality that would fundamentally sap the clear duty of the state to wield science and technology for “economic development, welfare and for the Nation’s security.”

Similarly, to the exasperation of its leaders, as late as 1955 the Foundation also had to continue to explain to other sections of the government the reasons that basic scientific research represented an inherently unclassifiable endeavor, a full decade after *Science: The Endless Frontier* had supposedly been accepted as consensus. In that year, the CIA distributed inquiries to government agencies on the so-called “strategic information problem,” premised on the stubborn notion among intelligence leaders that, despite the accepted normal process of the open dissemination of basic scientific research, a balance must nevertheless be struck between the “need to know” of the U.S. public and “the disadvantages accruing from revealing the information to the Soviets. In general, it is a disadvantage to reveal to the Soviets any item of information regarding the U.S., except for propaganda or psychological purposes.”

The Foundation curtly refused to provide documentation on this ‘problem,’ instead issuing a statement—one of hundreds explaining the same “linear model” concept that the agency had been obliged to produce since its creation—that “advantages accruing to a potential enemy tend to be more than offset by the advantages to ourselves gained through the freest possible dissemination of

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137 For Alan Waterman, “Notes for Budget Hearing: Item 4 – Security and Loyalty Matters,” February 5, 1955, box 26, Alan Waterman papers, LoC.
basic scientific information.”  

The CIA seemed not to understand the inherently unclassifiable nature of basic research—as a separate intel report put it, “The status of science determines the status of technology and the status of technology determines the war potential of a nation.”  

To the NSF—whose nascent program of 585 predoctoral and postdoctoral fellowships was subjected to even more stringent security restrictions than other government programs—this seemed to represent an almost willful misunderstanding of science.  

The drumbeat from scientists and non-scientists alike continued to strengthen, as technoscience acolytes tried to convince non-specialists that retrograde politics had inflicted years and years of untold damage on America’s global strength. A common illustrative refrain was to appeal to the example of the Nazis’ disastrous subordination of science to leaders’ political will, which late in the war scuttled advanced early work that had been performed. Germany, as Bush argued, had mortgaged its scientific advancements for a paradigm in which “nincompoops with chests full of medals presided over organizations concerning whose affairs they were morons… shot through with suspicion, intrigue, arbitrary power, formalism.”  

Another common example was the Soviet Union’s use of ideological purity to derail research during the Lysenko Affair, a policy which even the Kremlin had disavowed. James Killian, president of MIT, warned that “the whole problem of security

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139 Neil Carothers, “Statement regarding the information available within the National Science Foundation on the Strategic Information Problem,” 1955. RG307, 4 - NSF Historian file, entry UP-UP-1, Stack 103-Row 37-Cpt 15, container 21, NARA.  
procedures and policies at the present time may be one of the things that is most hazardous to our future research and development activity in this country in relation to military problems.” And even the Republican senator Harry Cain, a member of the Subversive Activities Control Board and lapsed McCarthyite, admitted that with the security frenzy “we have constructed an apparatus which can destroy us if we don’t watch out.” Cain went directly to the White House to take President Eisenhower to task on this count in a meeting in the summer of 1955.143

Ultimately, in an attempt to find some consistent policy and common ground, White House chief of staff Sherman Adams, on behalf of Eisenhower, asked the National Academy of Sciences to produce a report suggesting potential solutions. NAS president Detlev Bronk commissioned a Committee on Loyalty in Relation to Government Support of Unclassified Research, whose findings were released a year later on March 13, 1956. The committee’s conclusion was unequivocal: “A fundamental contribution leading ultimately to the cure of cancer… would be no less beneficial to all humanity for having been made by a communist.” Loyalty, then, “should have no special relevance to unclassified research, and there is no reason for singling out research for the application of loyalty requirements which set it apart from the multitude of other unclassified activities engaged in by the Government.”144

143 Ben H. Bagdikian, “What Price Security?” Providence Journal, March-April 1955, box 184, Vannevar Bush papers, LoC. Cain found Eisenhower receptive but distant as he argued his case; within hours of the meeting, however, the President was rushed to Walter Reed Hospital for emergency surgery on a near-fatal bowel condition, which sidelined White House activities for the short-term thereafter. C. Mark Smith, Raising Cain: The Life and Politics of Senator Harry P. Cain (Bothell, Wash.: Book Publishers Network, 2011).
In the end, the Academy’s report was accepted as a statement of executive policy for federal research, quelling scientific discontent to some degree after a decade of suspicion and paranoia. But it must also be noted that this put an end only to the onerous effect on basic, unclassified research, leaving the vast complex of sensitive and secret work under a different paradigm entirely—and this despite the realms of open and secret R&D actually overlapping considerably in terms of personnel and even laboratory space by this time.

The perceived importance of science and technology, then, caused it to bear the disproportionate brunt of the injury that Cold War paranoia inflicted on government activity, all while the same paranoia fueled the growth of government science and technology activity. Certainly, this made for messy state science. But it also fed into the ways technoscience advocates framed and reframed their cause. As Ben Bagdikian wrote, “Because security has been a sacrosanct subject, because powerful men insisted that methods are unimportant, and because criticism has often been silenced by accusations of disloyalty, a body of incompetence and waste has been tolerated as it would be in no other activity of government.” Ultimately, the targeted Cold War ‘chill’ is one of the starkest yet most ironic pieces of evidence illustrating the move of technoscience to centrality in Americans’ conceptions of their new place in the world.

146 Bagdikian, “What Price Security?”
Conclusion

We can interpret scientists’ increasing alarmism as the 1950s progressed to be a learned behavior. The paradoxical combination of public incomprehension and the intense limelight of centrality to national power produced professional tensions and frustrations in the technoscience community. As the primary stakeholders in the ways that state-supported R&D developed, however, technoscience lobbyists pulled the levers they thought would find the most public purchase. As the Soviet bomb, the Korean War, the security chill, and the development ideology of the 1950s all churned, this meant increasing appeals to security, global power, the strength of Soviet science, and the dire language of “falling behind.”

This was largely a trap of scientists’ own making. The discourse of technoscience-as-power was largely their discourse—it came through S:EF and the Berkner Report and the Bulletin of the Atomic Scientists and the fights over the NSF. Scientists’ brandishing of national strength as a political weapon, that is, represented a double-edged sword. As the 1950s wore on, the high stakes of their arguments meant that the ongoing inadequacies of the state began to seem to them and their

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147 See the new collection of papers, Brown, Lipton, Morisy, eds., Scientists Under Surveillance: The FBI Files (Cambridge, Mass.: MIT Press, 2019). Note that, as Jessica Wang illustrates, the “chill” was certainly leveraged as a political tactic, and likely exaggerated. For example, the number of scientists employed by the U.S. government increased between 1950-52, indicating a frustration more in words than in deeds (Wang, Scientists in an Age of Anxiety). It is also important to note that the discourses of stockpiles and danger also brooked some dissent among public intellectuals, particularly as time wore on. Lewis Mumford, for example, argued that the people behind Cold War technoscience were drunk with the power of their own creations and should not be blindly followed: “The inventors of nuclear bombs, space rockets, and computers are the pyramid builders of our own age: psychologically inflated by a similar myth of unqualified power, boasting through their science of their increasing omnipotence, if not omniscience, moved by obsessions and compulsions no less irrational than those of earlier absolute systems: particularly the notion that the system itself must be expanded, at whatever eventual cost to life” (Lewis Mumford, “Authoritarian and Democratic Technics,” Technology and Culture vol. 5, no. 1 [Winter 1964]).
followers like existential threats to the nation’s global interests. By 1957 the international valences of U.S. scientific and technological power—like the failed Point Four, the risible attaché program, and the security barriers to multilateral science exchange—seemed incoherent, contradictory, and damaging to the Atlantic alliance.

As the former science attaché William Forbes wrote, “our position as moral leader is far weaker than most people in this country believe.” The application of rudderless U.S. technoscientific strength to the wider world had seemingly boomeranged back against the high-tech hegemon itself. The United States had dropped atomic bombs, poisoned fishermen, polluted the atmosphere, and failed to use its superiority to seek amenable geopolitical solutions with other nations, all while lacking a centralized or cogent scientific and technological foreign policy, and failing to adequately support those programs it did have. As Forbes exhorted, “We risk losing the peace unless we can attain a higher moral and ideological status than we now enjoy.” Ironically, one of the major initiatives that Forbes believed could help bridge such a global divide was a renewed, robust science attaché program—the original, of course, having been bungled, mismanaged, and now existing only as a dusty memory.148

The President’s Scientific Advisory Committee agreed with Forbes. In a memorandum for the Office of Defense Mobilization two years after the attaché program collapsed, the PSAC now identified an “urgent need” to place U.S. scientific liaisons in “many foreign countries,” as well as to bolster NATO with American R&D advisors. With considerable understatement, the Committee

noted that these initiatives had proved “difficult to manage through existing mechanisms,” but would now be ideal programs for the National Science Foundation to take up—despite that agency having been left out of the attaché scheme in favor of the State Department to begin with. The Committee offered no wisdom, of course, on how the engrained shortcomings of the program—including foreign suspicion and the persistent lack of what Forbes called “strong roots in Washington”—might be overcome.  

The PSAC also urged that the U.S. encourage an “exchange of scientific personnel” through scientific congresses, multilateral projects, and international meetings, and that it should “grant[...] more fellowships for visiting scientists and students.” This would represent, it said, “an integral part of the basic national security policy.” What it did not say, of course, was that science administrators had been consistently pleading with decisionmakers to end the isolation of U.S. research via these exact proposals for years. Nor did it mention that powerful actors in the American state had been militating against these precise schemes for more than a decade. As Alan Waterman wrote, there was now a tendency, “deplored by the entire scientific community, for international scientific congresses and conferences to avoid the United States as a meeting place because of the obstacles to their visits interposed by immigration and visa requirements.”

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150 DuBridge to Flemming, February 23, 1956.

The primary factor fueling this urgency in the mid-1950s was an increasing paranoia that the USSR had accelerated its commitment to scientific and technological advancement. In 1955, the NSF and National Research Council released a two-year intensive study of the Soviet science complex that caused much consternation and hand-wringing in Washington. Authored by Nicholas DeWitt of Harvard’s Russian Research Center, *Soviet Professional Manpower—Its Education, Training and Supply* was a technoscientific bombshell. It concluded that the USSR had “reached a position of close equivalence with or even slight numerical supremacy over the United States as far as the supply of trained manpower in specialized professional fields is concerned. The Soviet effort continues. Our own policies... will decide whether within the next decade or so the scales will be tipped off balance.” The impact of these shocking words was quickly made manifest: The following fiscal year (FY 1957) represented the first time the NSF actually received the appropriations that the White House requested for it.152

In the face of these revelations, the PSAC concluded that the United States had sat on its hands for too long. The “grave” intelligence on Soviet capabilities now made it “questionable whether the U.S. enjoys meaningful technological superiority over the USSR... Our ability to keep abreast in this technological contest depends on the manner and extent to which we use our technological resources for this purpose and on public awareness that long-term national survival may be at

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That which technoscience advocates had been arguing for a decade seemed now to be coming to fruition.

Exacerbating the growing sense of panic was the fact that the government was not even well-organized enough to know exactly what the U.S. technological capability actually was. As the PSAC put it, there was too little technological clarity in national security planning, and too much blind faith in the notion that a slow material buildup was acceptable, premised on the false notion that the nation would continue to enjoy the luxury of a “long peace.” The State Department, too, needed to be more alert—as the Committee put it, State’s job was “to conduct our international policy in such a way as to not put too great demands on our weapons systems... We need to understand how we can use our technology to further our winning of allies; to build up our allies in order to overcome logistical disadvantages.”

Amid the growing atmosphere of alarm, scientists also seemed to turn inward and on each other. In doing so, however, they also raised and reiterated persistent realities about the sluggishness with which science and technology programs had been rolled out during the previous decade. Using charged, sexualized language, Lee DuBridge—now chairman of the PSAC—argued that “the sources of the strength and virility of American civilization” now hung in the balance. The new Soviet challenge had certainly come as a shock, but “possibly such a shock was needed to induce us to examine the status of our own progress.” Why was it, he wondered, that American students were

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153 Draft letter, Chairman, Science Advisory Committee to Honorable Arthur S. Flemming, December 11, 1956, RG359, Subject Files, 1957-62 (MLR 1), box 18, NARA.

“encouraged to avoid ‘tough’ and ‘technical’ courses?” What explained the decline of the prestige of teachers? And why was American science and technology so decentralized? As the committee mused, “Can responsibility, authority, and budgetary control be concentrated in a single chain of command?” Although “technological superiority” was an immeasurable quality, it was nevertheless crucial that the nation “concentrate effort on using our own democratic methods to optimize the full development and utilization of our own talents and resources.”

The threat that the U.S. might imminently “lose the lead” only increased the frenzy of ominous warnings circulating in Washington. Organizations as varied as the NSF, Scientific Manpower Commission, American Association for the Advancement of Science, and the Ford Foundation increased their lobbying efforts. Allen Dulles, director of the CIA, began speaking out publicly on the matter. Lewis Strauss, head of the AEC, pleaded personally with President Eisenhower that the U.S. would be unable to maintain its world leadership in the peaceful uses of atomic energy if the current circumstance persisted. And the Senate Armed Services Committee pored over evidence that there were five jobs available for each engineer and scientist graduating from American universities.

Even private industry joined the chorus. General Electric, for example, took out two-page advertisements in a variety of major weekly magazines calling for aid to education, the encouragement of young people into science careers, and even, if necessary, direct funding to

155 Letter, Lee A. DuBridge to Honorable Arthur S. Flemming, February 23, 1956, RG359, Subject Files, 1957-62 (MLR 1), box 18, NARA.
156 Letter, R.H. Scott, Charge d’affaires, September 20, 1955, FO 371-114425, UKNA.
universities from the private sector. “Progress is our most important product,” noted the glossy ad, while featuring an image of a small man standing next to a gigantic slide rule representing America’s present “critical shortage.” Next to him loomed a page-height, much larger man, representing the more virile future. The symbolism was clear—and the crisis was consensus.

All told, the United States found itself in considerable disarray by 1957. After a decade of haphazard organization for the new role of science and technology in the arena of global power, the nation found that a committed rival hegemon with a more dedicated and concentrated bureaucracy could not only threaten the primacy of ‘Yankee ingenuity,’ but could surpass it altogether. The fracas of science attachés, the stunting of Point Four, and the ongoing security chill, all represented symptoms of a deeper contradiction: The clash between a new formulation of power and the insufficient deployment of statebuilding and resource allocation required to nurture it.

Yet, as Anders Stephanson has summarized about the growth of U.S. global engagement in the first half of the century, “Each moment left an experience, a consciousness, a referent, some frame of engagement that was not there before.” So it was with science and technology. Although these programs mostly failed, they allowed technoscience champions to construct a worldview and an ideology that fed into a growing sense that America’s destiny would be bound up with its capacity for material innovation and achievement. As Dwight Eisenhower put it, “world technological leadership carries the inherent responsibility before the world of using technology to help all peoples achieve a

157 Ibid.
better life… An imaginative and vigorous effort on the part of citizens’ organizations and the Government can, I am confident, maintain for us the technological superiority upon which our economy and our national security so critically depend.”159

The rhetoric of those words failed to match the reality before 1957, but in them we can see the axiomatic acceptance of a line of thought that can be traced down the branches of an ideological tree, from the Berkner and Steelman reports, to Science: The Endless Frontier, and even to Radlab. Technoscience champions had had much to say since the Second World War, and by the late 1950s the disregard with which their words were persistently met fed a sudden and explosive sense of fear in the face of a global technological challenge.

There was one area of the state, however, that did learn the lessons of the British exchange and the war, had internalized the tenets of the Tizard Generation, and had enjoyed the independence and latitude to build up a state R&D complex of its own based upon the technoscientific ideology of power, one which would be ready to deploy fully once the general will called for it. We will now turn to the role of the military in stoking the furnaces of technoscientific global power during a period in which the rest of the state so repeatedly faltered in doing so.

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159 Dwight D. Eisenhower to Dr. Bevis, April 3, 1956, box 26, Alan Waterman papers, LoC.
Chapter 5: The Light under the Bushel

One day in June 1940, Major General Henry Aurand was called to the office of General George Strong, head of the U.S. Army’s War Plans Division. Forty-six years old and in charge of the G-4 Plans and Requirements section, Aurand had made a name for himself as an ardent modernizer in logistics and ordnance, forcefully campaigning against what he perceived to be the entrenched traditionalism of the Army’s old guard. Instead of taking part in a routine meeting that summer day, however, Aurand entered Strong’s office to find it occupied by a group of delegates from the British Army, commanded by Lieutenant-Colonel Donald Campion. This was a shock, and quite possibly scandalous. With the Roosevelt administration officially committed to neutrality, the presence of British army brass in Washington represented a potential political bombshell. That the U.S. War Department was not only in touch with the British military but was hosting them clandestinely in the Munitions Building on the National Mall represented a secret of the highest order to which almost nobody in Washington was privy, not least Aurand.

General Strong quickly brought him up to speed. The British had just escaped total catastrophe at Dunkirk and were seeking U.S. assistance in rearming. The immediate task was to funnel American surplus materiel to Britain in order to help it get back to fighting condition. The longer-term project was comprehensively to determine British resupply needs vis-à-vis the United
States’s ability to fulfill them. Aurand was to be Britain’s official point of contact with the War Department.

Since it was out of the question that the covert British delegation continue to meet in the army’s offices in the Munitions Building, Aurand was led to an unassuming apartment block on Washington’s K Street—within a stone’s throw of the White House—where the British visitors had rented a series of flats. Aurand spent nearly every day for the rest of the summer creeping through the alley between K and I Streets, furtively climbing up a fire escape to reach the anonymous apartments. There he met in secret with Campion and his associates, hammering out exactly what Britain would need and what the United States could send. By the following February, the $7 billion appropriation calculated by Aurand’s team, and the extensive shopping list for armaments that accompanied it, became the initial basis for the confidential arrangement’s successor program—now legalized, civilianized, and given a new name: Lend-Lease.¹

But Aurand’s historical significance is not limited only to his efforts to send U.S. arms to a secret ally. To be sure, in the coming years he would work even more closely with Britain, becoming its fierce advocate in Washington, rallying support for its cause, and harmonizing the supply and logistics bureaucracies of the two countries in a new Combined Production Board. Just as important, however, was the example and symbolism of Aurand’s role in the United States after the war was over.

In 1946 he was appointed by General Dwight Eisenhower to lead the Army’s short-lived Research and Development Directorate. There he became an active promoter of the idea that the U.S. military’s future strength would hinge primarily on its command of science and technology—and, just as jarringly, that this should be accomplished by mobilizing the nation’s civilian scientists. As he argued in autumn of that year, “The scientists and the engineers of other nations are making a supreme effort to place the military potential of their respective countries at the top. We must not only not be surpassed, we must stay ahead.”

Aurand, then, was an ambitious officer whose worldview had been deeply shaped during the war by close contact with Britain—that is, with other ways of doing things. He was a soldier who sought to shake off what he perceived as ingrained institutional backwardness in the American armed forces, one who thought expansively about the changing nature of U.S. power and the sources from which it derived, and one who vigorously promoted the mobilization of science and technology to meet the imminent challenges of the world ahead. And of greatest importance to the United States, he was not alone.

In fact, Aurand was but one of a host of young officers in the U.S. military who had seen the scales fall from their eyes as a result of the war, the British exchange, the unprecedented institutional arrangements that resulted from it, and the powerful new technologies that were produced by it. Between 1940 and 1945 there arose a cohort of military thinkers—mostly junior, mostly from the reserves—who began to recognize the gravity of the strategic and material changes occurring within

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and beyond the borders of the United States, and who felt that it was their business both to theorize and put into practice the idea that the country’s welfare, security, and power would depend in the future upon the extent to which the American state could perpetuate the technoscientific changes wrought by the war.

This chapter tells their story, and why it was important to the shape that science and technology ultimately took in the United States.

Military members had been the other people in the room, metaphorically and literally, when the Tizard Mission bore its technological gifts. As previous chapters have shown, the civilian-centered OSRD and facilities like Radlab were the primary products of the transatlantic exchange, but those institutions also built extensive collaborations domestically with the armed services. Although tensions certainly still roiled military-civilian relations in the United States, there nevertheless arose—far down the military pecking order, and largely away from the gaze of the war’s principal actors—a small cohort of young officers who were, like Aurand, not in the thrall of old ways of thinking and who were profoundly affected by the lessons that had been taught by the war-forged new direction in state-driven science and technology.

Through a confluence of unlikely circumstances that this chapter will detail, in the first years after the war this small cohort found itself possessed of a unique ideology commensurate both with the country’s unexpected new global role and the technological changes that had helped bring it about; of the distended resources held over from wartime mobilization; of a fortuitous dearth of oversight from both their military superiors and the distracted policymaking arena; and of clear ideas
about how to leverage all of these factors for the perceived strength of the military and the country. Meanwhile, as we have seen, the United States in the first decade after the war was repeatedly jolted by political growing pains as its leaders, politicians, and public reconciled anachronistic ideas about the state with the ambiguous new burdens of superpowerhood. As a result, many of the bureaucratic levers of U.S. power were simply unready for major commitments consistent with burgeoning new ideas connecting knowledge and innovation to military strength and geopolitical power. Looking around and finding themselves alone, new believers in overlooked corners of the military thus made the decision to do it themselves. They would keep wartime institutional arrangements alive and shepherd U.S. science and technology forward into a brave new world.

Nowhere was this more the case than in the Navy. As this chapter will show, members of the fledgling Tizard Generation succeeded in molding a small, newly-created institution—the Office of Naval Research (ONR)—toward the realization of their ambitious goals. From very narrow beginnings, the ONR by the 1960s had pioneered research into digital computing, cosmic rays and solar radiation, global positioning and satellite tracking, ultra-long range sonar, atmospheric circulation, ultra-high altitude telemetry, extreme survival technology, and biomedicine and cancer; it had launched the Viking and Vanguard rockets; and it had sponsored a dozen Nobel laureates. More importantly, it had served as the de facto ‘Office of National Research’ in the critical first years after

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3 Draft, Alan T. Waterman, “The Science Record of the ONR,” box 51, Alan T. Waterman papers, LoC. Further discussion on the ONR’s scientific and technological developments follows in this chapter’s “Legacy of the ONR” section.
the war, when the rest of the American state lay largely prostrate in the takeup of research and development as instruments of geopolitical power.⁴

The ONR was thus in the right place at the right time to fulfill a seemingly urgent national need. But how did these activities actually end up making the ONR the germ of the U.S. techno-state? Apart from the new knowledge and innovations listed above, the answer lies in two factors: its continuity of people and its continuity of vision. In the first instance, the ONR represented the crucial middle stage in the relay between the British exchange and its wartime effects on the one hand, and the global projection of U.S. technology as a hegemonic lever on the other. The torch that was lit by the Tizard Mission, by Radlab, and by the OSRD was passed onto a generation of science thinkers who imbued the ONR and other agencies like it with their vision of a broad, deep, state-driven frontier of scientific inquiry that would surely yield untold Radlabs and Manhattan Projects in the future. These people sought to permanently crystallize the institutional, contractual, and ideological measures that the war had brought into being, and in so doing created a proven model of U.S. state-science for the rest of the century. The contracting system they devised; the projects they sponsored; the landscape of laboratories, mainframes, telescopes, rockets, submarines, and copycat agencies they left in their wake; all of these fundamentally shaped the American government’s relationship with science and technology—even if it was not quite ready to launch this complex as an active diplomatic program just yet. Finally, the people themselves went on to positions of power and influence in new organizations like the National Science Foundation, in advisory councils like the President’s Science

Advisory Committee, in other military research divisions, and in heavy and high-tech industry. The ONR was thus the school from which the shapers of twentieth-century American technoscience matriculated into national and global leadership, for better or for worse.

As this chapter will show, these actors sculpted the shape of midcentury U.S. science and technology largely away from the main stage. Mostly unnoticed amid the tumult of a new nuclear age and the apocalyptic paradigm that informed U.S. public debate in this period, they dutifully chiseled and honed the philosophy of the Endless Frontier and the narrative of technoscience-as-power for a new national and international context. They learned to speak the language of science-as-national-security as geopolitical circumstances demanded. They contributed to the perverse Cold War language of scientists as weaponized “stockpiles,” and drew the military inextricably into the laboratory. They also inaugurated an era of staggering scientific and technological achievements funded by a wealthy state still finding its global footing. The flame that they lit, however, flickered under an institutional bushel until such a time as the nation found itself casting about for a new and powerful narrative of national power, development, and leadership—precisely the eventuality that came to pass in 1957 when the Soviet Union launched Sputnik. The new technoscientific regime, sculpted in a relative vacuum over a decade and a half of trial-and-error, was at that point appropriated and put on show for the rest of the world to awe at—allies, rivals, and developing countries alike.

As a final point, this chapter helps paint a more complete picture of the causes and ideas surrounding the militarization of U.S. science and technology in the mid-twentieth century. The
voluminous historical literature on the subject focuses overwhelmingly on the motivations, capitulations, and dissentions of scientists themselves, often while treating their military sponsors as monoliths with a natural proclivity to suck peaceable research activities into the dark orbit of the American war machine. My cause is not to doubt the intentions of many of the dangerous warhawks of the early Cold War period—indeed, these pages should make evident that there were deep divides between such problematic leaders and other, more deliberative elements of the U.S. military and policymaking establishment. The chapter, however, in line with the rest of the dissertation, seeks instead to recover the conceptual pivots that saw new ideas about global power implanted into the American state during and after the Second World War—pivots that are crucial to follow wherever in history they cropped up, including the military. When we do so, we find complicated narratives that, to be sure, are not incompatible with critiques of militarization to which I am fundamentally sympathetic, but which also help to illuminate that, first, it didn’t have to be this way—the divides between the open-minded ONR and more powerful and hard-lined military leaders clearly illustrate the contingency inherent to scientific militarization in the U.S.—and second, that progressive ideas about the practice of research and development for the national good came to embed themselves in surprising places during a messy moment of American statebuilding—places like the armed forces.

In order to fully illustrate these complexities and progressions in military thought, we must first look at early manifestations of the desire to make permanent the wartime science arrangement. And nowhere was this on more urgent display than a major meeting of military officers in April of 1944.
Twilight of the OSRD

As we have seen, the war integrated academic, industrial, and military scientists in a way unprecedented in the American experience. Federal research and development expenditures, a modest $67 million in 1940, approached $2 billion over the subsequent four years, and state actors—in the form of bureaucrats, science administrators, and military leaders—suddenly found themselves empowered to make sweeping research, production, procurement, and deployment decisions over dramatic new technologies like penicillin, synthetic rubber, and jet engines.\(^5\) One of the largest centers of gravity for this flurry of activity was the coordinating behemoth, the OSRD, which leveraged its enormous resources and informal, largely unregulated leadership structure to link together academic science departments, military research organs, British science and industry interests, and a collection of newly formed, centralized laboratories modeled after Radlab. Despite a persistence of institutional suspicions and interpersonal tensions, civilian and military scientific realms had successfully become integrated in productive ways: military liaison officers maintained sizeable staffs at Radlab and other OSRD laboratories; the OSRD, in turn, regularly sent scientists to military research facilities, as well as training grounds like Patuxent and Quonset; and civilians were frequently sent into active war theaters to conduct operations research.\(^6\)

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\(^6\) J.A. Furer, “Memorandum for the Secretary of the Navy: British Paper on Naval Research” April 6, 1945, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 68, NARA.
There was one problem, however: the OSRD was ticking and timed to self-destruct upon the resumption of peace. Always a temporary wartime agency, its civilian army of scientists seemed more than anyone to be hotly anticipating its closure. As President Truman’s personal adviser, Harold Smith, recalled it, when he met Vannevar Bush in private to urge him on behalf of the White House to keep the OSRD running for the good of the country, Bush was nearly reduced to tears, protesting that “I can’t hold them”—he faced a revolt from the civilian scientists of the nation’s research laboratories and universities wanting to return to their campuses. A typical example was in the Radio Research Laboratory at Harvard, whose chairman, Fred Terman, was moved in the fall of 1944 to issue a chastening announcement to his scientists reminding them that the war was still far from over; that they had a duty to see their commitments to the armed services through to completion; and that it was “very important that we not lose our ability to differentiate between future plans and present realities.”

To the new group of technoscience champions in the military and scientific communities, the termination of the OSRD thus seemed to be a thread that, when pulled, might unravel the entire successful wartime R&D arrangement. The urgency of this anxiety was informed by a history still well within the memories of most career officers. Recognition was growing that the demobilization process of the First World War had been disastrous for American technoscience, and there was nothing to guarantee that 1919 would not happen all over again in 1945. Memorandums crisscrossed

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7 Oral history interview, J. Merton England with Don K. Price, April 18, 1975, RG307, 4 - NSF Historian file, entry UP-UP-1, stack 103, row 37, cpt 15, container 44, NARA.
8 Restricted circular, “Dr. Terman States Immediate, Future Plans,” October 23, 1944, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
military wires urging that, in the words of Rear Admiral H.G. Bowen, the “sad situation” of the
interwar period would “not obtain after this war.”

The problem was that the leaders of the armed services did not think as one on the issue. As
Captain Carroll Tyler worriedly summarized, despite the world-changing science and technology that
had been deployed in the war, the average senior officer remained “not only highly conservative but
definitely reactionary,” meaning that they were unlikely to “open their councils and citadels
wholeheartedly to the scientific brotherhood.” For their part, scientists had not traditionally felt “any
basic responsibility for the defense of the country,” and were “strongly opposed to the application of
their science to the destruction of people.” Science promoters in the military thus seemed to be in a

These worries spurred military technoscience champions to action even before D-Day. In
April 1944, Rear Admiral Julius Furer, the Navy’s Coordinator of Research and Development, and
General William Tompkins, the Army’s Special Planning director, convened a major conference on
postwar military R&D needs, inviting 25 bureau chiefs, laboratory heads, and science coordinators

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9 H.G. Bowen to Rear Admiral T.D. Ruddock, USN, July 20, 1945, RG298, stack 370, Coordinator of Research and
Development, General Correspondence 1941-46 (Entry UD-1), box 24, NARA; and Hearings, National Science
Foundation Act (H.R. 8448), Subcommittee of the Committee on Interstate and Foreign Commerce, U.S. House of

10 Capt. C.L. Tyler, “Comments on the Relations Between the Military Services and Science in the National Security
Program,” April 23, 1945, RG298, stack 370, Coordinator of Research and Development, General Correspondence
1941-46 (Entry UD-1), box 52, NARA.
from the War and Navy departments to the Navy building in Washington. Vannevar Bush was brought in to lead the proceedings, and he characteristically moved to shape the agenda of the highly-ranked officers seated around him. The discussion that ensued reveals much about the state of military thinking about technoscience by this stage in the war.

The foundational premise of the summit was that academics would not be interested in government or military work in peacetime and that “some way should therefore be found to keep the best scientific minds in the country interested in national defense research.” The problem, it seemed, was not in formulating a vision for the national security potential of technoscience, but rather in selling it to the science community and the general public. Despite internal disagreements, the officers present at least shared a recent history—their careers had latterly been staked on the incubation of advanced R&D. Some now went so far as to fear that they were in advance of the general mood on that front. Would a diffident Congress realize, as Rear Admiral Alexander Van Keuren did, that military power might subsequently depend on “the whole scientific world in the United States?” Would military attempts to perpetuate wartime research result in a “witch-hunt” against the “merchants of death,” as Admiral George Hussey, Chief of Naval Ordnance, feared?11 General technoscientific strength was not yet broadly associated with power in the public eye.

Others in the room had the opposite worry—that policymakers and the public had so awakened to the power of science and technology that they would seek to control it to the military’s

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11 “Proceedings of Conference to Consider Needs for Post-War Research and Development for the Army and the Navy,” April 26, 1944, Room 3601, Navy Department, Washington, D.C., RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
detriment. Presaging the ‘conveyor belt’ ideology that would reach the public a year later in *Science: The Endless Frontier*, the Army Air Force’s development guru Major General Oliver Echols noted that “most of our research has come from the bottom on up, not from the top down.” This lesson made him “awfully afraid” of the type of superagency being proposed by Senator Kilgore—a body that might “organize and plan and coordinate and inspect research.”

Some saw the issue in simple material terms. Aside from foreboding claims about the demise of the OSRD, the crux of the matter was that when the Office went away, its billions of dollars of special appropriations would go with it. As Major General Wilhelm Styer, Chief of Staff of the Army Service Forces, put it, the military badly needed a coordinating and consulting (but not controlling) agency of the “best brains in the country to work on our problem,” in order to conduct cutting edge research in “slack years,” as was the norm in advanced industry. Styer was convinced that if the assembled officers could propose a coherent plan, Congress and the public would support it with funds in peacetime.

The central thinkers of the gathering, however, saw these fears and jurisdictional claims as subordinate to the urgent matter at hand: That the U.S. military needed to demonstrate publicly that it had awakened to the importance of coordinated technoscience. If it did not prove that it had both the legitimate interests and management wherewithal to continue the wartime program, it would be left behind as the nation pondered its postwar economy. This was not simply a matter of an appreciation for new weapons, but rather the need to show that the military recognized the value of a

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12 Ibid.
13 Ibid.
long-term, broad-based scientific frontier—as had other countries for decades. General S.G. Henry, the director of the New Developments Division of the War Department Special Staff, noted that the armed services should emulate in the automotive industry in liberating scientists “from pressure to get bugs out of a present model or to meet other immediate requirements.” It was precisely these powerful frontiers—the research that “has nothing to do with the immediate refinements of instruments or tools of war”—that were most important to the future and most under threat in the United States. “The people and our Congress are going to insist on a better coordination and cooperation,” he declared, and “unless we are fortified with some plan that is going effect a real coordination of research and development somebody is going to take it away from us.”

The RBNS and RDB

The meeting ultimately did produce specific recommendations, the most important of which was the appointment of a high-level Committee on Postwar Research, headed by Director of Defense Mobilization (and General Electric executive) Charles E. Wilson. This committee, in turn, proposed the creation of a “long-term program for national security,” to take the form of a Research Board for National Security (RBNS). In a joint letter, the Secretaries of Navy and War endorsed the technoscientific principles behind the proposal, affirming that “To insure [sic] continued preparedness along far-sighted technical lines, the research scientists of the country must be called upon to continue in peacetime some substantial portion of those types of contribution to national

14 Ibid.
15 "Historical Background, NSF, Appendix I: Historical Background of the National Science Foundation," 1951, box 173, Vannevar Bush papers, LoC.
security which they have made so effectively during the stress of the present war.”16 The far-sightedness was the key. At the cabinet level it was now recognized—or, at least, conceded—that long-term, even impractical-seeming research would henceforth be critical to American security.

Of course, “national security” was a term in flux at this early stage, with defense still perceived as just as critical to U.S. power than the global interventionism of the coming years. Scientific strength could thus shore up national security by acting as a homeland deterrent and creator of wealth, rather than necessarily an agent of international omnipotence. This measured view was best articulated by MIT president Karl Compton—chairman of the new RBNS—who told a gathering of NAS and military leaders that “America, with its material resources, its scientific skills and its industrial productivity, should be able, with only reasonable attention and effort, to keep itself in a position too impregnable to give any encouragement to any would-be aggressor. By ‘reasonable effort’ I mean an expenditure of time and money which would be insignificant indeed in comparison to the cost of fighting another war.”17

Compton and his team—promisingly comprised of science luminaries like Ernest Lawrence and I.I. Rabi, as well as an array of military officers and industrial researchers—quickly got to work. As the heirs apparent to the OSRD, they recognized the Atlantic exchange as one of the pillars on which their own military-civilian working relationship stood. Thus, one of their most urgent initial tasks was to secure the OSRD’s enormous trove of wartime documents and reports from the U.S. and

16 Ibid.
Britain. They also began submitting proposals for research programs to the War and Navy Departments.

The RBNS was doomed from the start, however. Like so many other state science programs in this period, it quickly fell victim to jurisdictional infighting, and its programs ended before they could even begin. The main point of conflict was whether or not the RBNS should be run by the National Academy of Sciences, which would essentially mean a return to the hierarchy that had existed before the war. Young officers like Furer and Capt. Carroll Tyler of the Naval Ordnance Bureau predicted that American technological security would backslide into the same doldrums it had occupied before the war if one of the primary pillars of national security was turned back over to retrograde thinkers. As Tyler testified to Congress, the elites who headed the NAS were “lackadaisical in their assumption of responsibility to apply their scientific knowledge to the needs of the country, particularly as regards national security.” Theirs was an “irresponsible attitude” more founded in the assumptions of the nineteenth century than the twentieth, he noted, and worse, their apathy only engendered further indifference on the part of the military.

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18 The OSRD had archived 99 percent of documents and reports relating to the British exchange, originating from both the British missions directly or from American liaison offices, both civilian and military. F.S. Cooper to D.Z. Beckler, “Transfer of LOGA Reports to the Research Board for National Security,” May 11, 1945; and K.T. Compton to V. Bush, “Suggestion for Ultimate RBNS Custodianship of Scientific Reports and Documents now the Property of OSRD,” RG227, Entry 169 (NC-138), box 41, NARA.
19 Rear Admiral J.A. Furer, “History of Office of Coordinator of Research and Development from 12 July 1941 to 19 May 1945,” July 28, 1945, box 32, Alan Waterman papers, LoC.
As the infighting continued, the White House intervened. Budget director Harold Smith axed the NAS-affiliated board as an unaccountable and antidemocratic fiefdom, and President Roosevelt directed Secretaries Stimson and Forrestal not to provide it with any funds. The RBNS was dead. 21

Thus, no matter the rhetoric of scientific and technological awareness that emerged from the 1944 summit, the RBNS flameout made clear that the military as a whole was not ready to embrace a comprehensive, centralized, civilian-focused program of the sort espoused by *Science: The Endless Frontier*. There still existed no broad agreement on how to bring civilian scientists into military decisionmaking in a post-OSRD world, and too many traditionalist officers held sway.

Undeterred, however, Vannevar Bush kept trying. His efforts demonstrated that at least one thing had changed from the prewar period: Military leaders were at least willing to commit to science and technology on paper. After the failure of the RBNS, Bush successfully lobbied for the creation of a Joint Research and Development Board with himself as chairman. He even managed to convince Secretaries Patterson and Forrestal to allow his own signature to stand in for theirs on science policy matters. It was a start. Civilian-centered science, moreover, had at least enough momentum to allow Bush’s board—now renamed the Research and Development Board (RDB)—to be included as one of the title-line initiatives of the sweeping National Security Act of 1947. The RDB would be on the same level as the Joint Chiefs of Staff and answer directly to the new Secretary of Defense. 22

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The darkening geopolitical context did nothing to help the RDB avoid the same doomed fate as its predecessor agencies, however. The Board ended up as middleman in a very tired, very entrenched, century-old jurisdictional fight between service branches that not only did not abate with the creation of a merged Department of Defense, but in fact came to something of a head. The demobilization between World War II and the Korean War, the consolidation of the branches, and the massive budget cuts of the period saw military brass grappling for the scraps of a dwindling pie. As new technologies brought troubling overlaps between traditional land, sea, and air boundaries, science became a proxy battleground for these disputes as a whole.23 The RDB—whose civilians were generally under pressure to conform to the views of the nonscientific Joint Chiefs of Staff—thus found itself in no position to suggest cancellations or collaborations between warring bureaus, nor to infuse the new regime with avant-garde ideas from the civilian world. As the Navy’s Alan Waterman put it, “the scientist in civil life says no to coming under the National Military Establishment, the officer says no to bringing in a strong civilian delegation into the National Military Establishment, and a member of the RDB staff wonders why they cannot handle the problem.”24

The RDB limped along in this fashion for the next six years, even as its budgets grew. The Board’s military representatives constantly maneuvered for the good of their own services, and the

23 See, for example, the so-called “Admirals’ Revolt,” which saw a heated dispute between the Navy and the new Air Force about the technological and strategic dimensions the military should take in the future. Among the institutional histories written on this object is Phillip S. Meilinger, “The Admirals’ Revolt of 1949: Lessons for Today,” Parameters, September 1989.
24 Letter, Alan T. Waterman to Irvin Stewart, January 17, 1949, box 31, Alan Waterman papers, LoC.
Joint Chiefs of Staff stubbornly continued to wall off policymaking from the civilians. By the outbreak of the Korean War, science coordination in the DoD had become so ineffective that proposals were even entertained to bring the OSRD back from the dead (not taken up), or to vest more military research coordination in the White House (taken up, via an executive order creating an Office of Defense Mobilization). The RDB itself was ultimately abolished in President Eisenhower’s sweeping reorganization of the Defense Department in 1953.

The lesson was clear: Well into the 1950s, any attempt at interservice, military-wide coordination for science and technology—especially if civilians were in charge—amounted to so much tilting at windmills.

**Army**

But that did not mean that the individual branches themselves didn’t have personnel thinking about the need for a new technoscientific regime, or that they had been unaffected by the British exchange and the institutional reforms brought by the war.

Secretary of War Robert Patterson counted among those who acknowledged the need for changes in the insular manner in which the military had previously interfaced with R&D. In March 1946 Patterson wrote to General Dwight Eisenhower that, after years of analysis of the Army’s research programs, “I believe that it would be well to consider certain organizational changes.”

Eisenhower agreed, and in April 1946 released a landmark memorandum to both the Army’s General

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and Special Staffs and to his principal commanding generals. In it, he declared that it would henceforth be the policy of the Army to give both generous support and maximal working freedom to the nation’s scientists, so they could work in aid of vital national security concerns.27

Eisenhower was no R&D theorist, but fortunately the Army had its share of young, technoscientific progressives he could draw ideas from. Indeed, the memorandum itself had actually been authored by a man named Edward Bowles, the personal science consultant to former secretary Henry Stimson.28 Bowles’s career arc is an exemplary window into the genealogy of the American state-science awakening. As an accomplished radio expert at MIT before the war, Bowles had been one of the select scientists invited by Alfred Loomis to work at Tuxedo Park; while there he studied aircraft detection and blind landing problems. When Taffy Bowen and the Tizard Mission’s delegates first demonstrated the cavity magnetron to U.S. officials, Bowles was one of the few Americans in the room. In the days that followed, it was Bowles who worked to find space at MIT for Radlab, and Bowles who helped recruit top researchers to work there. For his obvious scientific and organizational skills, the War Department soon plucked him to serve as radar and electrics advisor to Stimson.29

Now on the military side of the ledger, Bowles helmed an Army science advisory staff of 47 specialists, who frequently traveled overseas to war theaters to ascertain development requirements in

28 Lassman, “Putting the Military Back.”
the field. In consultation with Vannevar Bush, Bowles convinced Stimson to create a New Developments Division, which was to work with the OSRD on weapons testing, and which was empowered to appeal directly to the Chief of Staff and Secretary of War.\footnote{James E. Hewes, Jr., From Root to McNamara: Army Organization and Administration (Washington, D.C.: U.S. Army Center of Military History, 1975), chapter 3, \url{https://history.army.mil/books/root/chapter3.htm}. Note that the NDD was largely relegated to troubleshooting, hamstrung as it was by disagreements with technical bureaus over testing and bureaucratic procedures. Note also that the NDD was one of the organizations sent to Germany as part of the scouring for scientists, equipment, and knowledge by the Allies (as described in this dissertation’s Chapter 3). Sharon Watkins Lang, “SMDC History: 1945 Report Recommends Missile Defense Research and Development,” July 22, 2015, U.S. Army, \url{https://www.army.mil/article/152658/smdc_history_1945_report_recommends_missile_defense_research_and_development}.} After the war ended, Bowles worked with Patterson to lobby for permanent state mobilization of science for national security, as articulated in the memo he ghost-wrote for Eisenhower.\footnote{Lassman, “Putting the Military Back.”} Bowles was thus a figure who came in on the ground level of American technoscientific mobilization, leaping with his counterparts from the laissez-faire tinkering of the Loomis days to the bustle of Radlab via the British exchange, and taking those lessons to the military and ultimately to the postwar national security apparatus. In short, Bowles embodied the Tizard Generation.

Science elites considered Bowles’s memo a watershed demonstration of the opening of the military mind to the civilian science establishment, as well as a prescient vision of the importance of technoscience to American power. The policies laid out in the memo so excited Bush that he sent a copy to every scientist and engineer he had been closely associated with during the war.\footnote{Maj. Gen. H.S. Aurand, “The Army’s Research Program,” \textit{Bulletin of the Atomic Scientists}, vol. 2, nos. 9-10, November 1, 1946.} Ten years later still drew attention to it, reminding friends like MIT president James Killian that the now-
president of the United States had once put his name to such a forward-thinking statement of R&D policy. For his part, Killian agreed that the memo was “an exceptionally fine and prescient document.”

It is not hard to see why someone with Bush’s worldview and lobbying agenda would be excited by the memo. In a two-pronged analysis, Eisenhower acknowledged both the new centrality of science and technology to national security and the need to put civilians in positions of authority—an enormous departure from the insular structure of the prewar military. “The lessons of the last war are clear,” Eisenhower declared; much of the military effort for victory had been “effectively discharged only through the invaluable assistance supplied by our cumulative resources in the natural and social sciences.” Long-range defense planning could now only be done in the light of predicted developments in science and technology, and “as further scientific achievements accelerate the tempo and expand the area of our operations, this interrelationship will become of even greater importance.” Eisenhower dedicated the Army to a series of policies aimed at bringing civilian scientists into the highest levels of military planning, thereby giving scientists and industrialists “the greatest possible freedom to carry out their research,” and inculcating a broader appreciation and concentration in the mind of every uniformed official of the importance of science and technology.

This last point was of prime importance for those junior figures pushing for technoscientific changes: The nation’s soldiers and sailors, they believed, needed indoctrination. In the view of Major General Henry Aurand—the officer who had helped to resupply Britain in the early days of the war,

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34 Eisenhower’s memorandum was excerpted in Aurand, “The Army’s Research Program.”
and who Eisenhower now tasked with implementing his proposed new R&D organization—the services could fulfill the promise of technoscience only by looking critically in the mirror. Civilian-military integration, he wrote in an editorial, was "an intra-Army affair. It can be brought about primarily by the indoctrination of Army personnel."35 Across the Potomac, Chief of Naval Research Paul F. Lee also called for a permanent organization dedicated to R&D comprised of both top-rate civilians and military officers. The most important reason for doing this, he wrote, “is that by doing so we will, over a period of time, indoctrinate the entire military establishment with the vital importance of science to national security. We will also reduce the time lag which has occurred all too often in the past in the adoption of new scientific discoveries to national security."36

What would implementation of Eisenhower’s institutional mandate actually look like? As those tasked to carry it out saw it, the foremost task in inculcating technoscientific futurism in the military was to cleave scientific research away from the ephemeral concerns of procurement and weapons production.37 As Eisenhower and Bowles suggested instead, the kind of research that had just won the war “must be given the greatest possible freedom”—free, that is, from immediate materiel concerns and the wants of procurement officers, who had hamstrung visionary thinking for so many years.38 Considering the military’s impulse for rigidity and control that had so frustrated Bush and his colleagues before the war, this was a remarkable conceptual turnaround.

35 Aurand, “The Army’s Research Program.”
36 Letter, P.F. Lee to Karl T. Compton, February 7, 1949, box 19, Alan Waterman papers, LoC.
37 Hewes, From Root to McNamara, ch. 4.
38 Aurand, “The Army’s Research Program.”
This idea was at the heart of the newly-created Directorate of Research and Development. Helmed by Aurand, the agency would supervise all the Army’s science and technology initiatives, undertake long-range research planning, grant reserve commissions and large salaries to outstanding civilian scientists, and send officers to civilian universities and laboratories to receive technical education. It would report directly to Eisenhower and Patterson. Most importantly, it would be freed from any concern with immediate weapons needs, logistics, procurement, or the normal bureaucratic wrangling over resources—making an *Endless Frontier*-influenced bet, that is, that such freedom would dramatically improve the odds of major leaps in U.S. technological and military might. In this way, it would pivot the Army away from more than a century of incrementalism and instead institutionalize the new doctrine of long-range, broad-based R&D aimed at fostering dramatic advancements in technology. As Eisenhower’s deputy chief of staff, Maj. Gen. Lauris Norstad, summarized it for *Life* magazine, “We are not buying gadgets. Our capital is going into the exploration of systems of knowledge.”

It is worth pausing at this juncture to explore what the biography and evolution of Aurand tells us about the changing face of U.S. science and technology in this period. Major General Henry Aurand was already agitating for a sweeping modernization of the U.S. military by the early 1930s. Like his future colleague Secretary Patterson, he was incredulous at the notion that a nation so in love

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39 Hewes, *From Root to McNamara*, ch. 6.
40 Lassman, “Putting the Military Back.”
with automobiles could be content with a horse-drawn army. The coming of World War II presented him an opportunity to put his thoughts into action. As we have seen, in June 1940 Aurand was appointed as chief army liaison in the rearmament of Britain. After his summer of sneaking up fire escapes, Aurand began meeting regularly with the British Supply Council’s Jean Monnet and the British Purchasing Commission’s Arthur Purvis, and became a key promoter of British interests in Washington. Indeed, the British mission relied on him to be their mouthpiece in the face of American skeptics in the Army, to the extent that rival generals in the War Department suspected him of placing British interests before American ones.

As the transatlantic alliance went officially forward, Aurand envisioned the two nations’ industrial facilities—along with those of Canada—as one, and advocated that they be planned, coordinated, and managed “as though they were in one country.” As a result, he was named head of the new Combined Production Board, where he worked to harmonize the industrial machinery presided over by Lord Beaverbrook of the British Ministry of Supply and Donald Nelson of the U.S.’s War Production Board. This role required navigation of not just political and economic paradigms on both sides of the Atlantic, but also material compromises and standardization efforts, to say nothing of the need to convince the two sides to manufacture and use the other’s preferred designs.

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42 Reese, “Supply Man,” p. 17. See Patterson’s testimony in this dissertation’s Chapter 1 for his views on the mechanization of (and removal of horses from) the U.S. military.
43 Oral history interview, Aurand with Morrison, April 21, 1974.
In sum, Aurand spent much of the war playing a role similar to that of civilian counterparts like Carroll Wilson and James Conant of the OSRD Liaison Office—immersed, that is, in a transatlantic world of industrial output, modernization, and questions of logistics, standards, and supply for an unprecedentedly technological war. By the time Aurand was named head of the Research & Development Directorate—and he retained influence after its dissolution, staying on as the Army’s Director of Logistics—he had fully bought into the *Endless Frontier* vision of technoscientific global power. As he said in a speech to engineers in 1945, the people working to translate science into material strength now did so “in the face of changing national and international conditions—in the ‘changing social order.’” It was self-evident, therefore, that “the survival of our democratic idea, our concept of a Bill of Rights, and our way of life no longer rests upon the military forces you have created, but upon your assistance and insistence in the solution of our military engineering problems.” This was not simply a matter of stockpiling modern weapons; Aurand, like an increasing number of his contemporaries who were turning their minds to global matters, recognized the seemingly zero-sum nature of the technological race for geopolitical power. As he concluded, “We must not only not be surpassed, we must stay ahead.”

As the institution-building around Aurand played out, however, it was precisely the proposal’s radical undermining of the bureau-centered, traditionalist paradigm that thwarted the Army from fulfilling Eisenhower and Bowles’s sweeping vision. As soon as Aurand got to work, leaders of existing, gradualist technical services began to undermine him. Old hands like Maj. Gen.

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46 Aurand, “The Engineer and the Changing Social Order.”
Everett Hughes, postwar Chief of Ordnance, and Maj. Gen. Harry Ingles, head of Signals, railed against the “creeping authority” of the new R&D Division, recommending that it focus on finding inefficiencies in military R&D rather than trying to control it.47

It was a perfect storm. The formidable internal opposition began obstructing Aurand’s division just as the postwar wave of budget cuts and reorganization initiatives flooded the armed services as a whole. Suddenly there was no money for new equipment or personnel; researchers were forced to rely on leftover materiel from the war, essentially ruling out new R&D.48 Qualified scientists left the organization in droves, citing poor working conditions, while requests for new facilities by affiliated institutions like the Jet Propulsion Laboratory were flatly rejected on budget grounds.49

The last straw was the military reorganization of 1947, which cleaved off a large chunk of the War Department to form the new U.S. Air Force. This action divided the R&D functions of the General Staff between the new Army and Air Force departments, thus diminishing their importance on the staff itself, which had generally been sympathetic to Aurand and Patterson’s ideas. Aurand’s R&D Directorate was abolished in December 1947, and its functions redistributed to what would become known as the Logistics Division. The grand new push for free, unrestricted, and agendaless research and development in the Army had lasted only one year.50

Did the flameout of the R&D Division prove fatal for Army technological development in the near term? Historian Thomas Lassman argues that while new organizational innovations like the

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47 Lassman, “Putting the Military Back.”
48 Hewes, From Root to McNamara, ch. 6.
49 Lassman, “Putting the Military Back.”
50 Ibid.
R&D Division represented a deliberate attempt to pivot toward the latest advances in science and engineering, the rival technical services nevertheless “had already begun to position themselves on their own as proactive stakeholders rather than passive participants in this process.” The bureaus, therefore, were not necessarily simply seeking a return to 1939, and it is fair to suggest that they understood the goal of technological supremacy, if not the urgency or methods being advanced by the new scientific generation. Nevertheless, no matter how much work was performed by these technical services, the Army did not bring science back into high-level policy decisionmaking—nor distinguish it from immediate weapons procurement concerns—until 1952, when a new Chief of Research and Development position was created. It was the last department to do so.\(^{51}\)

As the failure of the R&D Division shows, the rivalries and conservatism of many leaders of the armed forces remained as entrenched as ever. But as the efforts of people like Aurand Bowles, and Patterson equally demonstrate, that entrenchment was now on a collision course with the combined influence of a new generation of progressive young officers; a war that had been waged with new technologies; a new vision of the security power of those technologies; and a new relationship with civilians that shone light into previously musty corners of the military research apparatus. The ‘old way’ was entrenched and powerful, but the new thinkers and doers were no longer content to stand idly by. And thus a way forward for their intended new program of American power emerged where it could emerge—at the edges of the action, in the peripheral vision of the powers-that-be. It emerged, by and large, in an obscure fiefdom with an uncertain mandate called the Office of Naval Research.

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\(^{51}\) Price, “The Organization of Support,” p. 32.
ONR

‘Bird Dogs’

For much of 1940 and 1941, the U.S. Navy’s science administrators were not at war with Germany, but instead seemed locked in a battle with civilian scientists.

As we saw in Chapter 1, the Navy had obstinately failed to heed the advice of civilians on anti-submarine warfare, which contributed to the early legitimation of the nascent NDRC. One of the naval officers most resentful of civilian meddling was Vice Admiral Harold Bowen, head of the Naval Research Laboratory—the very organization that had abandoned microwave aircraft detection research in 1937. That fateful decision had opened the way for the NDRC to become the Tizard Mission’s primary exchange partner in radar matters, and the American civilians and British delegates began feverishly organizing Radlab in October 1940.

As the laboratory and its civilian researchers steamed ahead, Bowen became increasingly anxious to wrest back control of this and other technologies upon which the Navy had missed the proverbial boat. In January 1941 he proposed to rebrand the NRL as the Navy Research Center and endow it with Bureau status and supervisory authority over the NDRC. This failed. Then, in a move of desperation, Bowen intercepted the NAS’s recommendations on anti-submarine warfare. Before forwarding the civilian report to Navy Secretary Frank Knox, Bowen attached a memo vehemently disparaging the NAS and its findings. This plan, too, backfired. Bowen’s addendum was so ugly that a disturbed Knox called on Jerome Hunsaker, a distinguished MIT engineer, to find a way to improve
frayed relations between military and civilian scientists.\(^\text{52}\) With a little help from a string-pulling Vannevar Bush, Hunsaker convinced Knox in July 1941 to order into existence a new Office of the Coordinator of Research and Development, a top-level technoscience body reporting directly to the Secretary of the Navy.\(^\text{53}\) Knox appointed Hunsaker—a civilian—to be its leader. Bowen was officially reprimanded—a defining moment in demonstrating that civilian scientists would now enjoy at least some degree of authority, influence, and autonomy in high-level military policymaking, at least for the duration of the war.\(^\text{54}\)

No one could have predicted that this new Coordinator’s Office, an obscure bureaucratic fiefdom, would go on to become a critical node of American statebuilding and self-identity in the immediate postwar period.

In keeping with his peacemaking mandate from Knox, one of Hunsaker’s first actions as Coordinator was to appoint a group of energetic junior reserve officers—lieutenants and ensigns—to identify and smooth out jurisdictional tensions between the Navy and other areas of state R&D, particularly the OSRD and Army. Thanks to their skill at ferreting out problems, this group came collectively to be known as the ‘Bird Dogs.’ The young group quickly set an aggressive agenda for the Coordinator’s Office, dispatching Navy liaison officers to any and every research project underway among the OSRD, Army, and British delegations. The group’s influence soon grew further, as

\(^{52}\) Furer, “History of Office of Coordinator of Research and Development,” LoC.

\(^{53}\) Ibid.

Hunsaker was replaced by Rear Admiral Julius A. Furer, a progressive senior officer who allowed the Bird Dogs even more latitude and authority.\textsuperscript{55}

The group wasted no time. As Furer wrote, “nothing slows down Government business so much as formal, official correspondence.” Instead, a policy to “accelerate the pace” was instituted, premised on “get[ting] things underway by informal discussion and agreement between people at the right levels, and later on formalizing as necessary the steps that had been taken.”\textsuperscript{56} Liaison officers to R&D projects were selected for the strength of their informal contacts with the relevant scientists, a departure from the usual paradigms of hierarchy and seniority. In this way, Furer’s office maintained constant, close, and personal ties to the proliferating new civilian models of state science like Radlab and the Radio Research Laboratory.\textsuperscript{57}

The office worked closely with the Tizard Mission and its successor groups in tightening the transatlantic science exchange between the British and American navies. Furer himself had served as Assistant Naval Attaché in London from 1935 to 1938, and lamented the paucity and suspicion that

\textsuperscript{55} Sapolsky, \textit{Science and the Navy}, 20. Hunsaker was plucked to lead the National Advisory Committee on Aeronautics, an agency he led until 1956, a year before it was reformulated and renamed for the post-Sputnik Space Age as NASA.

\textsuperscript{56} Furer, “History of Office of Coordinator of Research and Development,” LoC.

had marked attempts at exchange that period.\textsuperscript{58} Now in charge of the Coordinator’s Office, he laid out a series of concrete steps to harmonize the transatlantic technological effort. For example, the team realized that the Office of Naval Intelligence (ONI), Military Intelligence Service, and OSS were so undermanned that enormously valuable, globally-sourced scientific and technological data from secret agents, POWs, and British reports from the battlefront were being overlooked. The Coordinator’s Office thus inaugurated an Information Section, which compiled dossiers—the only such repositories then available in Washington—that revealed critical details on such strategic topics as the German-Japanese research exchange, the V-1 and V-2 missiles, and acoustically-steered torpedoes. A side effect of this undertaking was the reorientation of the ONI away from being a mere espionage “post office” towards the takeup of technological analysis as a crucial intelligence priority.\textsuperscript{59}

More tellingly, the various British delegations after Tizard—the British Admiralty Delegation, the British Army Staff, the British Air Commission, and the BCSO—all considered the Coordinator’s Office to represent the Navy as a whole, and Furer took full advantage. The Bird Dogs were clear-eyed about the boost the nation had been given by the British exchange; as Furer wrote, “the United States has profited greatly in recent years from the fundamental research of British scientists. There is no reason to believe that British scientists will not continue to make outstanding contributions to

\textsuperscript{58} Memorandum, J.A. Furer to Vice Admiral F.J. Horne, “Exchange of Information Between British Admiralty and Navy Department in Post-War Period,” April 12, 1945, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 68, NARA.

\textsuperscript{59} Furer, “History of Office of Coordinator of Research and Development,” LoC. The Information (or Intelligence Analysis) Section was headed by Lt. James P. Parker. Deserving of particular recognition—and noted by Furer at the time—was the significant work of two women who played a critical role in analyzing the technical intelligence, Marguerite B. Dawkins and Ensign Betty Cowie. Cowie can be seen in the Coordinator’s Office staff portrait in Colin Babb, “Commemorating the History of the Office of Naval Research,” The Sextant, August 1, 2016, http://usnhistory.navylive.dodlive.mil/2016/08/01/commemorating-71-years-of-the-office-of-naval-research.
knowledge having an application to warfare just as they have in the past.” Representatives from the Coordinator’s Office frequently accompanied British scientists on their laboratory visits. More importantly, the Office clamored for feedback from the British on America’s fledgling bureaucratic and state-scientific efforts. On exchange visits and tours, Furer reported, “A point was made to have [British] personnel visit the Office again before their return to the United Kingdom to give us the benefit of their observations, their impression of the developments underway and their suggestions for improvements.”

In line with this newly transatlantic outlook, the Navy began analyzing what made the British science establishment itself tick. In March 1944, for example, the U.S. Naval Attaché in London sent a report to the secretary’s office detailing the organization of Britain’s DSIR as a model for the U.S. to potentially emulate—“a convenient means of initiating and coordinating research of national interest.” A separate report on the British Admiralty’s peacetime research plans circulated through the offices of the secretary, the commander-in-chief, and the heads of all bureaus—and Furer personally delivered it to naval logistics head Admiral Frederick Horne. Four separate people, meanwhile, sent Furer a Nature article detailing a British plan to attract outstanding civilian scientists

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60 Furer to Horne, “Exchange of Information Between British Admiralty and Navy Department in Post-War Period,” NARA.
61 Furer, “History of Office of Coordinator of Research and Development,” LoC
62 Letter, H.A. Ingram to Office of the Naval Attaché, London, March 4, 1944, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 11, NARA.
63 Memorandum, Chief of the Office of Research and Inventions, “British Admiralty Research and Development Organization,” June 8, 1945; and Memorandum, J.A. Furer to Adm. F.J. Horne, June 2, 1945, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 68, NARA.
to government service in the postwar era, a correspondence that convinced Furer that “the entire world has become research conscious.”

Such internationally-minded theorizing about state organization for R&D became all the more compelling as tide-turning technologies reached war theaters in increasing numbers. The effectiveness of the new scientific order and the excitement of moving between academia, industry, Allied delegations, and military laboratories, solidly affirmed the frontier vision of naval and national power for the Bird Dogs. As Furer concluded in 1945, the American science and technology machine’s mobilization—a twentyfold expansion in four years—would have been impossible had it not been for the collaborative, civilian-military, interservice, and transatlantic activities of the Coordinator’s Office and its counterparts. Three years of experience had taught him that the military badly needed strong, permanent R&D coordination, “in order to make the greatest possible use of the scientific talent and research facilities not only of the naval establishment but of the country as a whole.”

His small group thus felt it had begun to build the organizational and doctrinal knowledge that was key to maintaining American strength after the war. But that near-existential urgency was

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64 Letter, Furer to Ralston S. Holmes, October 31, 1944, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 68, NARA.
65 “Statement of Rear Admiral J.A. Furer, USN (Ret.) on Navy Department Organization for Research,” January 8, 1945, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
66 Ibid. Note that Furer had been one of the key catalysts of the large April 1944 meeting of military minds on postwar research detailed earlier in this chapter. Furer had provided Bush and the other attendees with a memo declaring that some way needed to be found “to keep the best scientific minds in the country interested in National Defense research in peace times.” J.A. Furer, “Memorandum on Post War Research,” December 15, 1943, RG298, stack 370 - WWII and early postwar, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), container 52, NARA.
repeatedly frustrated by what they perceived to be the incrementalism and conservatism of the military establishment around them. A particular thorn in the Bird Dogs’ side was that the Coordinator’s Office was completely divorced from the existing naval research bureaus, and had no authority over them—nor were those bureaus particularly enthusiastic to collaborate with a new agency of upstarts. As a result, the information the office collected on the country’s navy-related research was more complete for the activities of the OSRD than it was for other parts of the Navy itself.67

It was not long before the Bird Dogs began thinking about ways they could upend this hierarchy and rearrange military R&D for the coming years. As early as 1943 they began to turn their gaze beyond the present war toward the remaking of American military research in their own image. After all, American technoscientific power needed to be nurtured, fostered, and maintained in a way that the country had never before attempted. The latecoming frenzy of civilian interest in military matters would surely die down once peace came, and industry would turn back to myopic self-interest. Progressive thinkers would have to lead by example.68

To do so, the Bird Dogs decided to appeal directly to Secretary James Forrestal.

Like so many of his counterparts, Forrestal represents an avatar for the American pivot to globalism during the war, as well as for the influence upon it of British institutional arrangements.

67 Furer, “History of Office of Coordinator of Research and Development,” LoC. Waterman noted that during the war the staff felt a sense of frustration “due to their lack of operating authority. However, it was evident that these officers gained a thorough education in naval technical problems. . . Above all they understood the value of research and came to know the NDRC scientific community and many of its contract scientists well.” Waterman, “The Science Record of the ONR.”
68 Sapolsky, Science and the Navy, p. 22.
Forrestal was a strong believer in planning, coordination, and expertise, and felt that the U.S. government, its bureaucracy, and its hierarchy of decisionmaking were anachronistic and inadequate for the country’s impending global responsibility. To Forrestal, only fortune and serendipity explained how America’s government had made it this far at all—and now it was to be tasked with reconstructing the world.69

Forrestal was heavily influenced in this conviction by close study of the British and their longstanding structures of international rule. Early in the war he had the opportunity to see something of what his country’s disorganization looked like through British eyes: Upon the arrival of Winston Churchill’s delegation to the United States in December 1941, the incredulous prime minister had informed President Roosevelt that intimate daily contact with the military secretariat was necessary to make war decisions. Forrestal watched the scramble as FDR created a Joint Chiefs of Staff on the spot. In the following years, Forrestal voraciously read the essays of Walter Bagehot and Lord Hankey on British government theory. He pushed for U.S. adoption of the British system of an elite administrative class of non-political civil servants. He even suggested that the U.S. embrace Britain’s model of the state leveraging the news media to serve foreign policy needs. Finally, in the immediate postwar period he successfully lobbied for the creation of a National Security Council, which he designed to emulate Britain’s Committee on Imperial Defense.70

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70 Ibid.
While Britain’s statebuilding deeply influenced Forrestal’s proposals, he also contemplated the role that R&D would come to play in shoring up the position of the United States. As he told Congress during his testimony for the NSC, the nation needed “new organizational forms responsive to our new world position, our new international obligations, and the new scientific and technological developments from the experience of war.” It would start in his own department—albeit not exactly in the way the Bird Dogs had initially proposed.

Under the consultation of reserve officer Lewis Strauss (later the polarizing head of the Atomic Energy Commission), in July 1945 Forrestal ordered a dramatic reorganization of the Navy’s research activities, mandating the creation of a new Office of Research and Inventions (ORI). Overnight, this order brought together the Naval Research Laboratory, Admiral Luis de Florez’s Special Devices Center from the Bureau of Aeronautics, the Underwater Sound Reference Laboratory from the Bureau of Ships, a newly-created Division of Patents with blanket purview over the entire Navy, and a Division of Planning taken wholesale from the Bird Dogs’ Progress and Planning section. Importantly, Forrestal codified the OSRD’s collaborative R&D model by endowing the ORI with the power to contract with academic and industrial scientists across a broad front of research problems, in line with the new thinking about freedom of science activity.

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73 Draft, Alan T. Waterman, “The Science Record of the ONR,” box 51, Alan T. Waterman papers, LoC.
74 Babb, “Commemorating the History of the Office of Naval Research.”
The good news for the young cadre of technoscientific thinkers in the Navy was that the ORI seemed to represent an enshrinement of the Bird Dogs’ philosophy and organizational goals for postwar R&D. The bad news was that Forrestal named an unlikely suspect to lead the new organization: the head of the already extant NRL, the cantankerous Harold Bowen—*that* Harold Bowen, the enemy of the OSRD and NAS, and the man who had taken the only official censure of his career in his attempt to prevent civilians getting involved in anti-submarine research in 1940.\(^75\)

Except something was different now. The Harold Bowen who now took command of the ORI was not the same man who had called Vannevar Bush and the NDRC “Johnny Come-latelies” before Pearl Harbor.\(^76\) In fact, the appointment of an utterly metamorphosed Harold Bowen seems such an unlikely *deus ex machina* that it would strain credulity were it fiction. It is unclear how and why Bowen’s philosophy on state science changed over the course of the war, but evidently a particular episode on his personal road to Damascus had been the success of the Manhattan Project. However it happened, by the summer of 1945—to the bafflement, shock, and pleasure of the Bird Dogs he now commanded—the new Bowen immediately launched himself and his ORI into enthusiastic cultivation of free fundamental science and generous contracts to academics. More importantly, while much of the rest of the nation’s science and military establishments screeched into gridlock—rancorous quarrels about the star-crossed alphabet soup of NSF, RBNS, AEC, and RDB—Bowen hatched a bold plot for his Planning Division to wrest atomic research from the Army, intercept the legions of the nation’s scientists streaming back to their universities, and position the Navy as the

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\(^75\) Sapolsky, *Science and the Navy*, 22; Gillmor, *Fred Terman at Stanford*, 290.

\(^76\) Ibid., 16.
nation’s vanguard of progressive R&D strategy—for the benefit of national security, international power, and the service itself.77

The centerpiece of the plan was to build a new naval Manhattan Project, commanded by Bowen, which would turn the Navy into a world-beating fleet of vessels powered by atomic reactors. It would also serve as a key node in keeping civilian researchers engaged in national security problems in peacetime. But before any of that could happen, the Bird Dogs’ temporary wartime office needed to be made permanent. To promote this, Bowen’s people fanned out across the country and across Pennsylvania Avenue, lobbying for the ORI to be made into an independent agency with its own budget and own authority.

The language used in these efforts is a revealing window into the futurist, world-encompassing technoscientific doctrine that had taken root in this small corner of the Navy. The advocates’ vision was no longer merely about weapons, and mere defense would no longer do. A long-term and unprecedentedly ambitious program was needed, one that was not dependent on the shadow of war for the country to support it. As Forrestal noted, “If a nation is to be scientifically prepared, its preparedness must be worked out in peacetime.”78 His counterpart, Robert Patterson—now Secretary of War—put it even more forcefully, telling Congress in late 1945 that “we must always have in mind that our modern warfare is not only total and global, but it moves in new realms of

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science and technology. There must be ample funds for technological research and development in the future years.”

Congress, it seems, was responsive at least to the idea behind these declarations. The text of the act creating Bowen’s agency was drafted in part by Forrestal, Strauss, and the distinguished naval counsel Struve Hensel, whom Forrestal had sent to London in June 1946 to study the British government he so admired. In signing Hensel’s bill, Congress put its imprimatur on a declaration that the Navy should “plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security.” The service should also centralize the acquisition and command of “world-wide scientific information and the necessary services for conducting specialized and imaginative research.” Imaginative research—this was the frontier vision of free-handed technoscience being passed into law for the first time. And pass into law it did on August 1, 1946, transforming the ORI into a new Office of Naval Research.

The ONR was to shape American science in the postwar years, but not in the way Harold Bowen dreamed. Specifically, his intention to create a naval Manhattan Project was quickly thwarted. His own obstinacy ran up against the maneuvering opposition of other navy officers, to say nothing of the red-hot sensitivity then prevailing in Washington on nuclear matters. As a result, the task of

building a nuclear fleet ultimately went to the Atomic Energy Commission and Bureau of Ships. Deflated, Bowen retired.\textsuperscript{81} Designing atomic vessels, however, had never been the only activity intended for the ONR. As a result of his canvassing, lobbying, and political maneuvering, Bowen left behind a new agency with a plump budget allocated directly by Congress; the autonomy of answering directly to the Secretary of the Navy; an overwhelming drive to seduce the academic scientists who had worked for the OSRD into navy work; and, most importantly, an agenda and ideology set by the futurist Bird Dogs themselves. It was, after all, the Bird Dogs’ Progress and Planning Division that became the ONR’s Planning Division. And it was the Bird Dogs who took it upon themselves to devise a new American R&D policy from whole cloth.

Despite its expanse of vision and the intensity of personalities like Bowen, the ONR had in fact come into being very quietly. The year 1946 was a frenzied one in both military and scientific circles in the United States. Tensions simmered about what the correct vision for strategic control of the world’s commons should be, and military-related research bodies like the RBNS and RDB stumbled out of their respective starting gates. Establishment science figures like Vannevar Bush and James Conant were too busy promulgating grand visions of the Endless Frontier to imbricate themselves in the unprestigious world of the Bird Dogs.\textsuperscript{82} Elsewhere in Washington, pitched debates roiled about oversight of the proposed Atomic Energy Commission and National Science Foundation. In short, almost all of the government actors who might have been potential stakeholders in the

\textsuperscript{81} Sapolsky, \textit{Science and the Navy}, 24.

\textsuperscript{82} For his part, Bush grudgingly assented to the ONR being an effective program (which he credited to the guidance of Conrad and Waterman), and also claimed to have been central to its creation and passage. Letter, V. Bush to J.B. Conant, November 4, 1946, box 27, Vannevar Bush papers, LoC.
ONR’s activities were too busy elsewhere to pay much attention to it. But the people working in it were going to make sure that the nation’s scientists paid attention.

To understand the doctrine underlying the ONR’s initial program, we must first look to its influential chief of Progress and Planning, the 41-year old Captain Robert Dexter Conrad. Just like that of Forrestal, in Conrad’s biography we can see the transatlantic influences on U.S. technoscience in the period.

After a stint aboard the USS Florida, Conrad completed postgraduate degrees in architecture at Annapolis and MIT. In 1933, he took a leave of absence from the navy to study at Cambridge University. Upon his return to the U.S. he served as a senior officer under Captain Lybrand Smith—himself the R&D deputy to Furer and the Navy’s delegate to the civilian-led NDRC. When the war began in Europe, Conrad was sent back to Britain, this time to the U.S. embassy in London, which became the beating heart of the Anglo-American science exchange after the Tizard and Conant missions were complete. There he served as Assistant Naval Attaché, and later Special Navy Observer. Armed with whatever ideas about the organization of research he may have picked up while in Britain, he was quickly named Head of the Progress and Planning Section of the Coordinator’s Office. His work there would earn him the Legion of Merit medal.

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84 Letter, Alan Waterman to Ivan A. Getting, April 7, 1958, box 19, Alan Waterman papers, LoC; and Waterman, “The Science Record of the ONR.”
Conrad was diagnosed with terminal leukemia and retired in 1947, but as the head Bird Dog and inaugural chief of the ONR’s Planning Division, he served as the lead theorist for American technoscience, power, and bureaucracy in his brief time. As his deputy at ONR later remembered, Conrad was an inspiring leader and “a man of vision and imagination,” who did more than any other individual “to chart what in those days was a novel course” for the American state. One of Conrad’s first tasks at the ONR was to travel the country on Bowen’s behalf, canvassing university scientists to persuade them to accept Navy contracts.

The charm offensive

This was no mean feat. Despite all the funding and cooperation that had defined the technoscientific war effort, many scientists were hesitant to continue contracting with the government—and especially with the military—in peacetime. As the eminent mathematician Mina Rees, then with the NDRC’s Applied Mathematics Panel, remembered, “I expressed grave doubts. I thought it unlikely that mathematicians would be enthusiastic about receiving money from the government to support their peacetime research and even more unlikely that money from one of the military services would be welcome.” The ONR’s first gambit, then, was to send people—including Conrad himself—to university campuses around the country to court scientists and administrators

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86 Conrad spent his last days as acting head of the new Brookhaven National Laboratory in Long Island, before his untimely death in July 1949 at the age of 44. Today the Navy’s top science award, given annually for outstanding contributions to naval research and development, is the Robert Dexter Conrad Award.


88 Sapolsky, Science and the Navy, 26

into the Navy fold.\textsuperscript{90} The office had two arrows in its quiver to do this: money—lots of it—and a progressive, futurist vision of the scientific frontier that ceded enormous autonomy and initiative to scientists themselves. Both of these represented very tempting fruit indeed to scientists.

First and foremost, the Navy had money, and scientists needed it. Big Science was now bigger than ever, and many administrators whose institutions had benefited from the wartime expansion of the state found themselves badly lamenting the passing of the OSRD. As Larry Owens has summarized, that agency’s closure “was complicated by contractors who had their eyes on the future and who knew how much more was at stake in sponsored projects than winning the war—including postwar status and influence, research support, and opportunities to redefine the fundamental mission and character of the university.”\textsuperscript{91}

In scientists’ self-interest the ONR saw pure opportunity. Touring the nation’s academic departments, ONR representatives made outlandishly generous offers that were nigh-on irresistible to researchers and their bosses. As the physicist Lee DuBridge recalls, “They actually came out and solicited project proposals. They came to the University of Rochester when I was there and said, ‘Don’t you want to build a bigger cyclotron?’ I replied, ‘Well, sure.’ And so, before I left, Rochester had a contract for a new cyclotron under ONR. …We wrote our proposal in 1946 and we got the money in 1946.”\textsuperscript{92} The ONR thus not only maintained continuities in the operation of the major

\textsuperscript{90} Sapolsky, Science and the Navy, 41.
\textsuperscript{92} Oral history interview, Dr. Lee DuBridge and Dr. William A. Fowler with Ms. E. Vernice Anderson and Dr. Judith E. Goodstein, Pasadena, Calif., October 20, 1981, RG307, stack 103, row 37, cpt 15, container 21, NARA.
wartime laboratories—including Radlab, which became the Research Laboratory for Electronics; the applied mathematics divisions at Brown and NYU; the Applied Physics Laboratory at Johns Hopkins, and numerous others—but also initiated a sweeping array of new programs, laboratories, and projects.93

Money was not the only enticement to draw the nation’s scientists into the ONR’s ambit. Equally important were its stated vision and liberality of terms. The office insisted that research contracts actually represented “partnership agreements,” and publicly guaranteed scientists “four freedoms”: The freedom to initiate research at their own discretion; the freedom to publish; the freedom to patent and copyright their work (with the government retaining royalty-free rights to any useful developments); and the freedom to teach, with an eye on bolstering the education of a new generation of American researchers.94

While these were considerable carrots for scientists, the ONR went further. The agency made a point explicitly not to solicit projects of potential interest to the military, but rather to let scientists themselves dictate research agendas. As Alan T. Waterman—the Yale physicist who emerged as deputy director and head apostle for the ONR—explained, instead of giving academics a range of problems of interest to the Navy, the ONR “[has] gone to the universities and said, ‘What’s on your mind? We know that you are working in this field. What do you think is the most important thing to

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93 Waterman, “The Science Record of the ONR.” In the nuclear field alone, construction began on new cyclotrons, betatrons, and synchrotrons, a comprehensive atomic research program pioneered by the ONR in the vacuum left by the still-nonexistent Atomic Energy Commission.

do in this field?’ They are experts.” 95 The distinguished oceanographer Roger Revelle, as one of the ONR’s early program officers, applied an even blunter standard: “Emphasis should be on the merit of the scientific approach. Navy relevance will follow. If the proposal emphasizes Navy relevance, turn it down.” 96

This deference extended to the conduct of the projects themselves. Proposals were judged only on their scientific merits, and once a project was approved, “the contractor proceeds according to his own judgment, and the Office of Naval Research does not participate in subsequent scientific decisions unless invited.” 97 In fact, the only scientific requirement imposed by the ONR was the filing of status reports every three months, which served an internal administrative function, rather than an auditing one. 98 Attempts at secrecy and classification—perhaps expected by scientists accepting research money from the military—were also explicitly avoided. As Waterman noted, the ONR believed that “true scientific research is incompatible with any restriction on the free flow of information.” On the contrary, the agency encouraged scientists to publish and disseminate their

97 Robert D. Conrad and Alan T. Waterman, “Comments on ‘Should Scientists Resist Military Intrusion?’ by Louis N. Ridenour, Spring Number of The American Scholar,” 1947, box 31, Alan Waterman papers, LoC. For more on the relationships, patronage, subsidies, and other factors between the military and scientists, and their potential effects on the projects that were proposed and chosen, see Paul Edwards’s discussion of “mutual orientation;” Harvey Brooks’s phrase “imaginative stimulation;” and Naomi Oreskes’s notion of “context of motivation.” Oreskes notes that the frequency of interaction between scientists and their military funders meant that an unviable project would be unlikely to develop far enough to be cut off; as Paul Forman noted, science in this way was “rotated” toward applications and development. Edwards, The Closed World; Oreskes, “Science in the Origins of the Cold War,” in Oreskes and Krieger, eds., Science and Technology in the Global Cold War.
98 Waterman, “Fundamental Research as a Factor in Maintaining National Security.”
work as often and as widely as possible, with the only stipulation being that they decline from speculating on possible naval applications. Any project that did happen to stray into classified territory would be presented with a range of options, with the researcher empowered as the primary decisionmaker on whether to continue or not. “No one,” said Waterman, “is asked to work in secret against his will.”

Part of this doctrine of free dissemination stemmed from the desire to keep researchers working from the comfort of their home institutions and laboratories. Rather than pressuring scientists to work together (a model that had proved successful in the vein of Radlabs and Manhattan Projects), the ONR sought also to honor many scientists’ preference for academia. The Navy might then urge researchers to publish and mingle in conferences, with the ultimate goal of fostering a Republic of Letters model of long-distance collaboration for the national good. By the end of 1947 the ONR had convened and sponsored conferences in metallurgy, nuclear physics, low temperature physics, and cosmic rays, among other fields.

Finally, the agency simply sought to court scientists. All these explicit statements of liberal contracting policy represented a concerted public relations campaign to let scientists know that the military was now valuing, elevating, and empowering them as the keepers of national greatness. Alan Waterman, ostensibly the office’s chief scientist, in reality functioned in this period mostly as a

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99 Conrad and Waterman, “Comments on ‘Should Scientists Resist Military Intrusion?’”
promotional strategist, canvassing the country to evangelize to scientists, industrialists, politicians, and any other interested parties, letting them know the good news about the direction of the Endless Frontier. For anyone skeptical, as Waterman told the conference of the American Association for the Advancement of Science in late 1947, “it would seem more fitting that you should find out for yourselves the extent to which our practices live up to our preaching. It is true that we have had from time to time very complimentary reports from many of the universities with whom we have dealings, for which we are deeply grateful. The final proof, however, remains an experimental one: how is it working out? Such an examination we heartily welcome, as also we welcome any comments or suggestion for improvement.”

The charm offensive paid off in spades. For the next half-decade the nation’s scientists flocked to and became dependent upon the ONR and its vision for the technoscientific future and the state’s role in it. If the primary impediment to the agency’s success had been scientists’ fear of control and restrictions by the military, then the progressive and devolved contracting system devised by ONR admirals Merton L. Ring, Frank Baldwin, Paul F. Lee, and others, solved it and opened the floodgates. Only four months after the ONR was established, MIT’s Karl Compton conceded privately that the Bird Dogs had “done a really remarkable job in establishing a degree of confidence and in persuading the educational institutions to cooperate in the scientific program along the lines which all agree are of exceedingly high priority as a basis for future national security.” A year later,

101 Address, Waterman, “Research and the Navy.”
102 Ibid.
103 Letter, Karl Compton to Warren Weaver, December 24, 1946, box 26, Vannevar Bush papers, LoC.
his deputy James Killian declared that “the Navy has shown not only how to write research contracts but how to manage research. The Office of Naval Research represents an extraordinary achievement in successful and enlightened government research management.”\textsuperscript{104} The sweeping Steelman Report (see Chapter 3) noted the “high esteem” in which distrustful scientists held the ONR, something it took as proof that more civilians were needed in the development of military policy.\textsuperscript{105} Even the skeptical Robert Millikan, the respected but aging Caltech physicist who abhorred state involvement in science and opposed expansion of the federal government, nevertheless approved of the ONR and its money—in his view, the Navy was an organization that happened to want to support science, rather than a science organization. It was hands-off and it let scientists take their own reins.\textsuperscript{106}

Caution is needed in taking such widespread and effusive praise at face value. As actors with sizeable stakes in the matter, scientists’ approval should not be taken to mean success of the ONR by some objective measure, but rather as the consummation of the movement of the scientists’ own doctrines to the center of military strategy and policymaking. Just as importantly, the worldviews of both civilian scientists and the ONR demonstrate the lessons learned from the war. The British exchange and relative strings-free contracting operation of the OSRD had taught the ONR’s principals that if scientists were given state resources and then left alone to charge the well of knowledge—as Britain had seemed to do before the war—then advancements with spectacular national security importance like penicillin and atomic bombs would follow. The fact that their

\textsuperscript{104} Address, Waterman, “Research and the Navy.”
\textsuperscript{105} Steelman, “Science and Public Policy.”
\textsuperscript{106} Oral history interview, DuBridge and Fowler with Anderson and Goodstein, October 20, 1981.
scheme was ‘good’ for scientists is beside the point; rather, it was that the scientists’ own proclamations about the frontier and the origins of the war’s technologies came to be embedded in the state in the form of the ONR. The actors’ categories and definitions of ‘success,’ that is, became the basis for the American state’s interest in technoscience as an avenue to global power.

Not that scientists had many places to turn. By the end of its first year, the ONR had secured its place as the only government agency supporting basic science in any substantial way—78 percent of all government science contracts that year, worth $45 million, came from the Office. Scientists attending major conferences like the American Physical Society began noticing that majorities of their papers carried acknowledgements to the ONR. Some academic departments derived as much as ninety percent of their research funds from the Navy. The nuclear scientist Philip Morrison noted grudgingly that “The Navy may be said almost without hyperbole to own all of nuclear physics which is not owned by the Manhattan District.” It seemed that the breadth of its program, the depth of its support, and the lack of viable alternatives had converted the Office of Naval Research effectively into the “Office of National Research” in these first postwar years.

By 1949 the ONR was supporting more than 1,000 research projects by some 3,000 senior investigators and their 2,500 graduate students at 235 institutions. Scientists clamored for contracts so much that the ONR found itself turning them away in droves—in the 1948 fiscal year, for example,

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107 Memorandum, Karl T. Compton for Dr. John Steelman, “Budget of Office of Naval Research,” October 23, 1947, box 26, Vannevar Bush papers, LoC.
the agency was forced to reject 66 percent of applications on the basis of lack of funds, even though three-quarters of those were deemed scientifically meritorious.\textsuperscript{110}

\textit{The ONR and the NSF}

We can see just how entrenched the ONR and its progressive leaders became in the country’s science picture by briefly examining the torturous process of transferring its programs to the NSF once the latter passed Congress in 1950.

The ONR had been conscious from the beginning that it was blazing a new trail in a field considered to be vital to national strength. It also knew that it represented a test run for what should have been a massive new civilian agency to permanently continue the work of the OSRD. As Conrad and Waterman wrote in 1947, “We are, in a very real sense, pioneers in establishing and maintaining the relationships of science and government which are becoming so essential to our national life. Our mistakes as well as our success will provide eventual guidance for the National Science Foundation.”\textsuperscript{111} To that end, the agency did not limit itself to contracting for science projects, but also instituted detailed studies on other countries’ state science and technology bureaucracies, as well as evaluated the potential scientific capacity of American bureaucratic arrangements in various fields.\textsuperscript{112}

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\textsuperscript{110} Alan Waterman, “Statement before the Armed Services Subcommittee, House Appropriations Committee,” 1949, box 48, Alan Waterman papers, LoC.
\textsuperscript{111} Conrad and Waterman, “Comments on ’Should Scientists Resist Military Intrusion?’”
\textsuperscript{112} For example, “Survey of the Administration of Research and Development in the United Kingdom,” Office of Naval Research, ONRL-35-52, December 31, 1952, RG298, stack 370 - WWII and early postwar, ONR Physical Sciences 1945-58 (UD-WW entry 7), container 2, NARA.
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In the race for global power, the military would refine U.S. state R&D, and then pass the baton to a civilian agency at the appropriate time.113

But a funny thing happened as the relay ran its course. Excited by the science flowering in their hands, the ONR’s leaders began resisting the idea of a total transfer of the nation’s free scientific activities from the military to the NSF. To be sure, the ONR remained a staunch supporter of NSF legislation and played a crucial role in nurturing the young foundation once it was founded. But as the Navy’s program became more entrenched, the ONR sought to manipulate the NSF’s responsibilities to ensure the Navy could be justified in retaining a sizeable number of research contracts for itself.114 As early as 1947 Conrad and Waterman began asserting that while their agency did represent an “interim trustee,” it was nevertheless “vitally important that the Navy maintain close and responsible relationships with frontier research in all fields of science of any conceivable interest to the national defense. We have paid the price of neglect in the past, and the direct relationships we now have with the scientific fraternity must not be broken.”115

It should not be assumed that this assertion of interest was solely a matter of protecting bureaucratic turf. The ONR was consistently motivated by its technoscientific conception of national power, as well as its understandings of the detrimental effects to that power that any discontinuities in R&D would inflict. Nor were these worries unfounded: As we saw in Chapter 3, the Navy and NSF were burned several times by budget administrators eliminating programs by transferring them from

113 Address, Alan Waterman, “New Vistas in Mathematics,” drafted January 8, 1947, box 31, Alan Waterman papers, LoC.
114 Sapolsky, Science and the Navy, 56
115 Conrad and Waterman, “Comments on ‘Should Scientists Resist Military Intrusion?’”
the ONR to NSF and then slashing the NSF’s budget by the same amount. ONR leaders thus made clear that they understood there to be many research programs “of great importance to the national research effort. They can be justified from the standpoint of Navy research as well as science. [The ONR] would be unwilling to drop these from their program without assurance that they would be continued by another agency.” In the context of a worldview in which maintaining the broadest possible front of science directly correlated with national strength, playing fast-and-loose with research programs would be a dangerous game to play.

The Navy’s desire to keep its own program is therefore understandable. More surprising, however, is the widespread resistance of civilian scientists to the removal of military oversight.

On the most basic level, there was a natural tendency for some scientists to set whatever ideals or pacifism they might have harbored aside for the material benefit of their careers and institutions. As the Bulletin of the Atomic Scientists lamented, “even though many scientists deplore the warping of the direction of research inevitable in a military program, some of the university people—with their fields well-established, their file of telephone numbers organized, and the money flowing freely—may hesitate to upset a going operation.”

But scientists’ hesitations went beyond that. Simply put, the ONR got it. This no-strings-attached corner of the Defense Department possessed the vision, resources, and latitude to let

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117 Minutes, “Conference with Representatives of the Office of Naval Research,” January 22, 1952, box 25, Alan Waterman papers, LoC.
scientists pursue research for the nation without having to answer to politicians or heavy-handed administrators. As the Nobel laureate William A. Fowler remembered, the ONR was “established and they were doing a very good job. There is no question about that. They had won the confidence of the scientific community almost unanimously in this incredible period just after World War II when Defense was funding essentially whatever we wanted to do. There is no question about it. We were never asked to do anything that we didn’t actually propose to do. There were many in the community who were opposed to change from having the ONR support basic research to having the NSF do it, mainly because they were so satisfied with the ONR.”119 In the summary of the National Science Board’s Vernice Anderson, “ONR had a hands-off policy, and I guess the scientific community was concerned that NSF would not be able to function in that same manner.”120

To a large extent, those fears were founded in reality. They played out, for example, in the case of Indiana University’s astronomy program under Frank K. Edmonson. As the NSF got underway and the ONR phased out its projects, Edmonson’s Indiana Asteroid Project became a “drop out” that was obliged to petition the NSF for support. The foundation agreed to support construction of a new Southern Hemisphere astrograph, but Congress denied its proposal three times until the NSF withdrew its backing. As Edmonson remembered, after the final rejection, “the Ford Foundation said, ‘Well, this looks like something worth doing. We’ll support it... The Ford

119 Oral history interview, DuBridge and Fowler with Anderson and Goodstein, October 20, 1981.
120 Ibid.
Foundation did very little additional reviewing before they decided to put money into it.\textsuperscript{121} Congressional rejection was a fact of life as the overmatched NSF attempted to support national science; it had not been a worry when contracting for the Navy.

This divergence, along with the constant political attempts to undermine the NSF, gave rise to perhaps the most delicious bureaucratic irony in the history of American R&D, one that pithily encapsulates the unintended militarization of state technoscience in the postwar years. As historian Don K. Price summarized in 1953, “the Congress was always inclined to cut down severely on the President’s budget for the National Science Foundation, which was supervised by a board including some of the leading scientists and educators in the nation, even while vastly larger sums were being distributed \textit{for precisely the same purposes} by junior officers in relatively obscure corners of the military departments.”\textsuperscript{122}

\textbf{What does the Navy want?}

What motivated the Navy? What drove those junior officers? Studies of this period often focus on the motivations, accommodations, and capitulations of the \textit{scientists}, taking the prima facie desire among military actors to wield new weapons as self-evident. But if we view that flattened portrait in relief, we see that the ONR’s motivations were wedded to broader pivots in the United States during this period, pivots towards a global consciousness and recognition of the power of

\textsuperscript{121} Oral history interview, Frank Edmonson with J. Merton England, June 28, 1979, RG307, stack 103, row 37, cpt 15, container 44, NARA.

technoscience to the nation. Weaponry was important, to be sure, but the ONR cannot be explained simply by a desire to stockpile bigger and better bombs.

On the loftiest, most abstract, and most global level, ONR thinkers saw their small organization as the Little Dutch Boy of proverb, imbued with a responsibility whose global ramifications far exceeded the program’s modest size. This had been foisted upon them by the historical moment. The British exchange, the war, the OSRD, the influx of foreign scientists, Science: The Endless Frontier—all of it had built to a sense that if the United States was now the sole guarantor of Western security, and science and technology was the guarantor of American security, then U.S. science and technology was in turn the chief guarantor of Western security.123 As Waterman insisted to the nation’s researchers, “Whether we like it or not we must face the fact that science and research have taken a commanding position in affairs. Scientific research has demonstrated its power both in peace and in war in such impressive fashion that the future and possibly the very existence of mankind may depend upon what is done about this fact.” In a new global paradigm, it was the responsibility of both the nation and its scientists to “meet our growing responsibilities effectively and intelligently.”124

In both war and peace, Waterman had said. As regards war, it is worth underscoring that many of the problems of warfare that had plagued human societies since ancient times had been solved only within the living memories the military leaders of World War II. In the judgment of Fleet

124 Address, Waterman, “Research and the Navy.”
Admiral William Halsey, for example, the war in the Pacific had been won by, in order of importance, “submarines first, radar second, planes third, bulldozers fourth.” All of those technologies had been devised or taken their present form in the years since the First World War. Likewise, it had only been in the previous four decades—again, within the careers of current senior officials—that electronics developments had made global communications so instantaneous as to erase them from presenting a serious logistic and planning obstacle to military operations. In the eyes of ONR strategists, the services had a responsibility to be proactive in the face of these changes. As Waterman put it, “modern war has proved conclusively that the military strength of a country is strongly dependent upon its scientific strength; it is, therefore, one of the duties of the Navy to assist in developing the nation’s scientific strength.”

In analyzing the ONR’s motivations, it is tempting to stop there: technology helps win wars. But as Waterman implied, the roots of American global power at midcentury necessarily went beyond the point of a sword, and it was vital that the military understand that. Observing with satisfaction the recent incursion of economics into military college curricula, Waterman noted that “it has been forced home on the leaders of the armed services that wars are won or lost on the basis of

126 Remarks, Alan T. Waterman, “The Role of Science in War,” Naval War College, Newport, R.I., June 3, 1952, box 47, Alan Waterman papers, LoC. Just looking at Halsey’s arc demonstrates this directly: he had sailed in the Great White Fleet in 1907-09, in a U.S. Navy still very much subordinate to that of Britain and in a world in which none of the technologies he mentioned had been either invented yet or (in the case of submarines) deployed in a significant military context. By the time he commanded the U.S. forces in the South Pacific in 1942-45, science and technology had imposed a sea-change on military affairs. For more on the changing strategy of World War II as technology changed logistical calculations, see Daniel Immerwahr, How to Hide an Empire: A History of the Greater United States (New York: Farrar, Straus, Giroux, 2019), chp. 17.
127 Waterman, “Government in Research.”
the national economic potential rather than on the current strength of the armed forces … It has, therefore, become of vital importance to the preservation of the nation that its military leaders be taught to understand the function of technology and the basic role of scientific research in forming the economic power from which the logistic support of all combat operations is derived.128

But the military’s interest had to go beyond merely pursuing a strong war footing via economic strength: If the nation’s preponderance of global power was its security, then the armed services had a duty to support all forms of it, not just those pertaining to weapons and bases. In the face of an enemy reliant on a revolutionary socioeconomic ideology, it was essential to the United States’ international leadership that it reduce its own material inequalities and spread its high material standards to other societies. And in the new U.S.-led world, that would ultimately be the responsibility of science and technology. As Waterman argued, “A military potential of maximum strength will not suffice for the preservation of free and democratic society unless it maintains and gradually enhances the qualities of living of all its people. The nation’s basic and applied research is, perhaps, the most essential of all the elements that contribute to these qualities of American life.”129

Considering the military leadership’s habitual resistance to modernization, the notion that the armed services should now concern themselves with butter as much guns was radical. But that was the

129 Ibid. In an example that was really pushing it, ATW noted that jet propulsion had the most ancient origin of all—“in the locomotion of the squid and humble clam,” Alan Waterman, “The Relation of Basic Research to National Security,” National Military-Industrial Conference, Chicago, March 14, 1957, box 46, Alan Waterman papers, LoC. 9147.
ONR’s position. If international stability was now a pressing security issue and of acute military interest, then the science and technology that undergirded it was the responsibility of the military, too.

But even so, why would a military agency pursue such a liberal program of science, rather than technological development? We saw in Chapter 3 that the civilian research community rallied around the blurry notion promulgated by S:EF that science begat technology. But what is perhaps surprising is the extent to which this corner of the Navy had also become convinced of it. As Waterman summarized it, “the current emphasis upon research is, of course, due primarily to the realization of its power in technological progress.”

But it was not Vannevar Bush who convinced the military of the importance of the scientific frontier. Rather, in the case of the ONR, it was the direct experience of the war, of the collaborations set in motion by the British exchange, and of the bureaucracies that had produced its technologies. The military branches gained direct experience of using the British-style collaborative laboratory model—in Americanizing the British proximity fuze program, for example, the Navy allowed a single group of scientists and engineers (described by Bush as “a group of wild, but very sane and sound, youngsters”) to see the project through from beginning to end; it allowed open collaboration between military, academic, and industrial scientists; and it gave considerable leeway to the researchers themselves in organizing and executing the project. The proximity fuze program seemed like a

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Bushian fantasy, and it yielded a highly successful technology of significant importance to the war effort.

The Bird Dogs and their heirs thus became true believers in the “linear model” of technological development, and with their new organization they believed they could catalyze it further. As Rear Admiral Paul F. Lee, Bowen’s successor as chief of naval research, declared, “From purely fundamental research studies comes knowledge which can have a profound effect upon the outcome of war.” Later, when post-Korea political pressures saw a squeezing of military science budgets, policymakers had at least to acknowledge the bedrock importance of basic science to national security. Defense secretary Charles Wilson, for example, said in 1953 that his department remained committed “to provide a flow of fundamental knowledge of the sort that the military establishment needs, now and in the future.” Such knowledge could only be produced by “maintain[ing] contact with the scientists of the country so that the scientists are encouraged to be interested in fields of potential importance to defense.”

Even those most opposed to government spending had at least to doff their caps to the concept of the scientific frontier.

The wartime experience imparted another lesson that became core dogma at the ONR: Since world-changing technologies came from any and all fields of science, it was vital that a national program of unprecedented breadth be supported. Admiral Furer asserted this as early as 1943, when he circulated a memorandum asserting that “every branch of scientific knowledge is involved in

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133 Statement, Secretary Charles E. Wilson, October 6, 1953, Army Navy Air Force Journal, October 10, 1953, box 25, Alan Waterman papers, LoC.
modern warfare, and it is no longer possible to assign the cognizance over any particular branch of knowledge to any one part of the war making organization.” As ONR (and later NSF) planners were wont to emphasize, many of the technologies of the war had had obscure scientific origins: atomic weaponry could be traced to the 1896 discovery of radioactivity by the Curies and Becquerel, while radar originated in British attempts in the 1910s to locate the earth’s ionosphere for the detection of thunderstorms. It was especially instructive that, in the latter case, radar had only transformed from peaceful atmospheric research to the device that won the Battle of Britain thanks to the breadth of interests of British science and the generosity, patience, and hands-off supervision of the British state.

The lesson for the ONR, then, was that it was in the national interest for the American state not only to support R&D, but to do so along the broadest possible front of fields. And since the ONR remained the nation’s only effective science agency, it itself would have to become interested in everything. As Waterman put it, by funding as broad a program as possible, “one overlooks no bets.” A wide-ranging program in the physical, medical, and biological sciences would help keep the Navy in close contact with the entirety of the national research community, and the service was

134 J.A. Furer, “Memorandum on Post War Research,” December 15, 1943, RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.

135 Waterman, “The Role of Science in War.”

136 Waterman, “Fundamental Research as a Factor in Maintaining National Security”; Conrad and Waterman, “Comments on 'Should Scientists Resist Military Intrusion?'”
confident that “few areas of endeavor are likely to be barren of results which affect the national defense.”

The concept of “spinoff” has been analyzed extensively by technology scholars, usually in the context of military technologies serendipitously finding traction in the commercial sphere. In the context of the ONR, however, it might be more useful to think of the Navy as pursuing a kind of “reverse spinoff” or even “spin-on” program. If the nation’s scientists could be allowed to amass a wide enough body of knowledge, then eventually something would loop back around and be useful to the military. As Waterman noted, “If the program is broad, then statistically one can be reasonably certain that something will come out of it somewhere, although it is a characteristic of basic research that one cannot predict the result of an individual project. It is only through this statistical method that results can be certain.” In underwriting massive accessions to the scientific library of the nation, the ONR embodied the belief that “ideas beget ideas” and would eventually turn up “untold treasures, still in the rough.”

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137 Address, Waterman, “Research and the Navy.”
138 Unfortunately, these terms are limited in their adequacy for this situation. In particular, “spin-on” has been applied to more recent national systems of innovation—particularly that of Japan—in which both military and commercial technologies are built from a common base of development knowledge. That is not my intended use of the term, as explained above. See for example Linda Weiss, America Inc.? Innovation and Enterprise in the National Security State (Ithaca: Cornell University Press, 2014); Linda Brandt, “Defense Conversion and Dual-Use Technology,” Policy Studies Journal (June 1994); Jay Stowsky, “From Spin-Off to Spin-On: Redefining the Military’s Role in Technology Development,” Berkeley Roundtable on the International Economy, Working Paper 50 (May 1991).
139 Waterman, “Fundamental Research as a Factor in Maintaining National Security.”
140 Waterman, “Government in Research.”
While the text of *Science: The Endless Frontier* had the luxury of being abstract, the ONR, as a bureaucracy dependent on planning and accounting, did not. So what sort of timelines did ONR planners have in mind for the fruition of their intangible program of untargeted science? *When* did they think they would have something to show for their enormous resources and patience? Public relations people like Waterman predictably avoided giving much detail on such matters at the time, but we can nevertheless read against the archive to get a sense of the time horizons in play. When we do, we find yet another example of liberal terms being promulgated by the ONR in this heady moment of postwar scientific futurism.

Key to understanding planners’ thoughts on timing is the way they explained the need for the United States to take up the broken mantle of formerly dominant European science. As Waterman noted, with the onset of war “the almost complete cessation of scientific activity in Europe and elsewhere in the world meant we could no longer depend upon the output of foreign scientists to help replenish our store of scientific knowledge.”\(^{141}\) The conventional wisdom among Bushites and Bird Dogs alike was that the war’s technologies had rapidly depleted the reservoir of European knowledge, and that its continued non-replenishment held grave implications for U.S. security. As the atomic scientist Harry D. Smyth noted, “the fountainhead of all our future scientific developments has run dry.”\(^{142}\)

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\(^{141}\) Ibid.

\(^{142}\) “First Annual Report of the National Science Foundation, 1950-51” (Washington, U.S. GPO, 1951), box 24, Alan Waterman papers, LoC.
The ONR thus took as its explicit mission the recharging of this well so that technologies could be extracted at some point in the future. But what point? In a vignette oft-recounted by the Bird Dogs, Nazi Germany was said to have fatally doomed its war effort by abandoning all long-term science in favor of short-term development in 1940. This seems to imply a technological payoff timeline of five to ten years. Similarly, an RDB report in 1950 cited the economic devastation of Russia and the hoped-for global stability of the United Nations to predict that no major war would arrive for at least ten years, thus giving the S:EF process time to play out—an adequate supposition of the delay before expected technological payoffs.

A different way to triangulate science planners’ thinking on time horizons is to observe how far backwards in time they cast their explanatory nets. Looking backward, J. Robert Oppenheimer summarized that “The real things were learned in 1890 and 1905 and 1920, in every year leading up to the war, and we took this tree with a lot of ripe fruit on it and shook it hard and out came radar and atomic bombs.” Looking forward, Waterman mused that in some fields like mathematics, “importance in applications appears only decades after the mathematical theory has been formulated.” By that accounting, then, it is not outlandish to suggest that some technoscience planners were thinking at a scale of decades before major innovations would pay off from programs like the ONR—at least in an ideal world.

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143 Sapolsky, *Science and the Navy*, 50.
144 “First Annual Report of the National Science Foundation, 1950-51,” LoC.
145 Budget Advisory Report of conference held November 9, 1950, Research and Development Board, box 96, Vannevar Bush papers, LoC.
146 “First Annual Report of the National Science Foundation, 1950-51,” LoC.
147 Waterman, “New Vistas in Mathematics.”
In the real world, of course, politics got in the way, as it always does. As David Kaiser has shown, discourses portraying scientists as the nation’s “most precious resource” and a critical “stockpile”—effectively commodifying researchers as weapons of war to be mobilized in the event of emergency—waned and waxed—but especially waxed—along the contours of geopolitical flashpoints like the Korean War.\(^{148}\) So it was with the ONR’s relaxed time horizons. For while the RDB at the outbreak of war in Korea noted that the U.S. had spent five years recharging its scientific well, it also said that “the Army, Navy, and Air Force are convinced that this is the time to reap the fruits of the research we have been carrying on at such great cost in the last five years.” With conflict raging in East Asia and military spending exploding across the board, leaders wanted science projects to “move out of the laboratory and onto the assembly line.”\(^{149}\) When push came to shove, it seems, the forbearance of the nation to explore the endless frontier could only realistically be stretched to about five years. \textit{S.\textit{EF}} and the Bird Dogs preached patience and nineteenth century-style reverence for scientists; Uncle Sam wanted fireworks.

Taking all of the above as read—belief in an Endless Frontier, recognition of the need for basic science to foster technological innovation, and an emphasis on a broad front of projects—there is one more question that presents itself in explaining the ONR’s program: Why like this? In its first


\(^{149}\) Budget Advisory Report of conference held November 9, 1950, Research and Development Board, box 96, Vannevar Bush papers, LoC.
year alone the ONR budgeted $45 million to university research, significantly more than its appropriations for industrial and naval laboratories combined. Yet the military had an array of ordnance and other in-house laboratories that could potentially have been converted, as well as a longstanding practice of contracting basic science to industry. So why did the postwar Navy so emphasize the need to court and support academic “longhairs” in university departments?

The answer lies in the politics of pleasing scientists that the war had taught. The universities were already stocked with field-leading experts and robust professional networks, and had constructed the pedagogical and administrative pipelines necessary for effective science. The war had also shown that it was impossible to get all of the best minds in a particular field to work in the same lab, and many scientists had no desire to leave the comforts of their home institutions in any case. The contracting system devised by Lee and his ONR colleagues thus provided a way of performing flexible state science on private salary scales, while simultaneously avoiding civil service red tape and—best of all—evading the political constituencies that inevitably accompanied public programs.

The clear lesson for the ONR was that the military needed the universities. To be sure, the Navy could and did run in-house laboratories and coordinate its own research projects. But it could not perform the crucial cultivation work—the training of graduate students, the movement in open professional circles, the freedom of inquiry—that academics could. It was a lesson that had been self-

151 Price, “The Organization of Support.”
evident since Bush and Furer’s planning meeting in 1944, when General Wilhelm Styer said that “research and development should be the most unrestricted thing we do. And it is only by keeping the restrictions off the people who are research-minded that they will develop things. They may develop a number of things that are of no value but every now and then, you will find one or two that will pay for all the work that they have expended.”

**Legacy of ONR**

What was the legacy of the Office of Naval Research? What did its history bring to bear on the crystallization of science and technology as a new form of U.S. power and an accepted duty of the state?

At the most obvious and basic level, the ONR spearheaded and supported an enormous—and, considering the extent of military science before 1940, astounding—volume of scientific projects, many of which went on to achieve far-reaching and internationally important results. Even the briefest of glances into ONR research activities makes clear the efficacy of the agency’s breadth along the ‘frontier.’ At the risk of adopting the historical actors’ logic on the validating nature of technological applications to basic scientific research, it is worth noting the extent of the ONR’s development impact in its first decade: By the late 1950s the ONR’s extreme high-altitude balloons Helios, Skyhook, and Stratolab had reached near-space, allowing for wide atmospheric and astronomical observation as well as altitude survival technology later used by NASA for its astronauts.

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152 “Proceedings of Conference to Consider Needs for Post-War Research and Development for the Army and the Navy,” April 26, 1944, Room 3601, Navy Department, Washington, D.C., RG298, stack 370, Coordinator of Research and Development, General Correspondence 1941-46 (Entry UD-1), box 52, NARA.
The ONR was responsible for the pioneering digital computer Whirlwind I at MIT, which was later developed by the Air Force into the SAGE continental defense system and which ultimately led to today’s familiar array of business and personal computers. It spearheaded studies into hearing loss and the mechanics of the human cochlea. It pushed for the design of a new class of purpose-built, civilian oceanographic research vessels responsible for a multitude of peacetime oceanic studies in the ensuing decades (the first of these ships was named, appropriately, the R/V Robert D. Conrad). ONR-funded sounding missions yielded the first seafloor map of the Mid-Atlantic Ridge, which a few years later unlocked the theory of plate tectonics. ONR-sponsored space research at the University of Iowa led to the discovery of the Van Allen radiation belts surrounding the Earth.\(^{153}\) ONR vacuum tube research went into electron linear accelerators; its shock tube programs influenced the design of intercontinental ballistic missile nose cones; and its acoustics and information theory research created new long-range submarine detection technologies.\(^ {154}\) ONR-sponsored atmospheric circulation studies changed contemporary understandings of the origins of tropical storms. ONR work at Stanford achieved precise measurement of nuclear spins. ONR sponsorship at NYU led Richard Courant and K.O. Friedrichs to publish their classic and influential guide *Supersonic Flows and Shock Waves*. An ONR program at Stanford developed a new klystron that bested the Tizard


Mission magnetron’s microwave power by many orders of magnitude. Contracts at Columbia and the University of Texas led to new developments in plastics for the repair of bone injuries and the treatment of nerve damage after surgery.\textsuperscript{155} And all of this was just in its first decade. In the national science picture, the National Institutes of Health did not reach the level of appropriations of the ONR until the mid-1950s, and the Atomic Energy Commission was so burdened in its early years that it simply outsourced much of its university science activities to the ONR, under which aegis work went forward on general physics, chemistry, metallurgy, ceramics, mathematics, geophysics, and cancer studies.\textsuperscript{156} By 1961 the ONR had racked up seven Nobel laureates, including Linus Pauling, Severo Ochoa, and Felix Bloch.\textsuperscript{157}

But, as with the Tizard Mission before it, the ONR’s legacy was not limited only to scientific knowledge and technologies; it also left an indelible imprint on the bureaucratic organization of R&D activities in the American state. Most directly, its success eventually spurred copycat science organizations in the Army and Air Force departments which tried, at least superficially, to pursue the same frontier logic of the ONR in their branches.

Significantly, in the case of the Air Force the model was championed by yet another luminary of the wartime R&D explosion, Louis Ridenour. Ridenour had been recruited by Edward Bowles to Radlab in 1941, and quickly became the laboratory’s assistant director. From this vantage he began

\textsuperscript{155} Waterman, “Statement before the Armed Services Subcommittee, House Appropriations Committee,” 1949
\textsuperscript{157} To date, the ONR has sponsored 63 Nobel laureates. “All ONR-Sponsored Nobel Laureates,” online resource, Office of Naval Research, \url{https://www.onr.navy.mil/en/About-ONR/History/Nobels}
ardently theorizing the postwar organization of U.S. research, and in the coming years chaired several committees on radar and the postwar organization of military science. One of the institutions he helped to create in this capacity was the Radlab-derived Lincoln Laboratory at MIT, which among other projects created the SAGE system from the ONR’s Whirlwind computer.158 When the Air Force was cleaved from the Army to become its own department in 1947, it named Ridenour as its inaugural Chief Scientist, and his efforts led to the creation of a new Air Research and Development Command. The new department also appointed a Deputy Chief of Staff for Development. These were important steps, since science and technology matters had always been the province of the Air Material Command, which had considered R&D merely an offshoot of its primary task of purchasing aircraft.159 Here again we can trace direct genealogical lineage from the experience of Radlab to new Cold War state-scientific forms.

The Army was the last branch to centralize science. In June 1951, it created the Office of Ordnance Research which, in a telling about-face from previous Army norms, was situated on the campus of Duke University. In yet another continuity, the OOR named James Killian—the deputy assistant chief of research at the ONR—to be its chief scientist. Like the agency it emulated, the OOR emphasized that “off-the-beaten-path proposals which combine scientific soundness with a high degree of originality are particularly sought. The policy is to obtain a wide distribution of truly basic

159 Price, “The Organization of Support;” Tubbs, "Establishing Air Research and Development Command: Two Civilian Scientists Played Key Roles.”
(and therefore usually moderate-sized) research projects among many institutions.” Likewise, one of its selection criteria was for “crucial areas on the periphery of scientific knowledge where results are likely to be of great importance to military or other human affairs.”

In 1952 the Army also created a Chief of Research and Development position, answerable to the Chief of Staff and Secretary of the Army. Later the same year, Secretary Frank Pace created an Army Scientific Advisory Panel comprised of civilian advisors. As Congress heard in a hearing on emergency organization for science, these actions went some distance toward raising the stature of science and technology within the Army, as well as improving the coordination of activities that had previously been scattered and lacking in direction. As Killian noted, the adoption in the Air Force, Signal Corps, Army, and Atomic Energy Commission of the ONR’s principles of science—as well as the university contracting system it devised—represented a “heartening” development in a “marriage [that has not] been free of domestic difficulties, even though it may be true love.”

All three military departments thus had ONR-style science divisions by the middle of the Korean War. But the alarm surrounding that conflict meant that for many national policymakers, suddenly those agencies seemed insufficient—statebuilding was lagging the global situation yet again. As the war drew on, public and political scrutiny thus heightened around the question of how the military should better streamline the nation’s science and technology for emergencies. In 1952,

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Congress concluded that the need for physical science was so dire that universities could be bypassed altogether and a direct basic research program run by the Secretary of Defense. While this recommendation ultimately failed, it was joined by other more practical ones, including a proposal for the creation of a science and technology committee with a direct line to the secretary, “composed of members of such stature and prestige that they can be of the greatest possible assistance to the Joint Chiefs of Staff.”163 Lastly, the Eisenhower administration’s 1953 military reorganization scheme abolished the flailing RDB and replaced it with a new Office of the Assistant Secretary of Defense for Research and Development.164

How do these seemingly mundane bureaucratic reorganizations implicate the ONR in a doctrinal paradigm shift within the defense establishment? It is too much to say that top brass had awakened to the power of the scientific frontier, particularly when considering the continuing obstacles that agencies like the ONR faced in the coming years. But the stated goals of the new programs in the Army and Air Force leave little doubt as to their heredity.

The Air Force, in particular, leaned strongly into the language pioneered by people like Bush and Waterman. In early 1957, the R&D Command’s General Thomas Power determined that it was of vital national interest to study comprehensively the country’s future needs in scientific manpower.

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and facilities. The Air Force commissioned the National Research Council to do so.\textsuperscript{165} The resulting report, nearly two years in the making, gave dramatic voice to the importance of technoscientific breadth and depth in U.S. power. Only the “great wisdom” of the ONR and its offshoots, the NRC argued, had “saved our nation from becoming a second rate power.” Expertise in the complexities of modern science now demanded “intimate association with those in the frontier of the work. The services cannot afford to insulate themselves from this frontier.” Nor would it do to target only fields conceivably of interest to the military, since “it is impossible to predict, with even moderate assurance, just which portion of the advancing frontier of science will yield a discovery which is highly important for military technology.” The report concluded that “the Department of Defense must maintain a vigil over all of the areas of developing science. Any other procedure could be catastrophic.”\textsuperscript{166}

The ONR also carried the torch of the Tizard Generation’s international orientation into the 1950s. The ONR was the direct inheritor of the OSRD London office—the central node of the British exchange after its genesis with the 1941 Conant mission. As the OSRD closed down, it moved its London operations to the naval headquarters at 18 Grosvenor Square, transferring personnel and

\textsuperscript{165} Diary note, Neil Carothers III, “Meeting with Colonel Ernst and Dr. Milton E. Johnson of the ARDC in Baltimore,” January 2, 1957, RG307, stack 103, row 37, cpt 15, carton 21, NARA.

\textsuperscript{166} “A Report by the Committee on General Sciences relating to Long-Range Scientific and Technical Trends of Interest to the United States Air Force,” NAS-ARDC Study Group, 1958, RG359, Subject Files, 1957-62 (MLR 1), box 17, NARA.
activities to the Navy wholesale.\textsuperscript{167} By 1947 Office of the Assistant Naval Attaché for Research-London (OANAR) had become a hotbed of transatlantic science activity, as well as a popular informal headquarters for visiting scientists, diplomats, and officials from inside the Navy and out interested in science and technology matters.\textsuperscript{168} The office took an active and robust interest in European science, sending reports home comparing other countries’ R&D complexes with that of the U.S. and making suggestions for emulation.\textsuperscript{169} The office soon sought to build on that success with other liaison offices both at home and abroad. ONR branches opened in Chicago, San Francisco, Los Angeles, and Boston, and while plans for a Latin America office fell through, an ONR Tokyo eventually opened in 1975.\textsuperscript{170}

Indeed, so successful were the Navy’s liaison activities that they overshadowed other U.S. attempts at technodiplomacy in foreign capitals. We saw in Chapter 4, for example, how the State Department’s science attaché program had considerable problems getting off the ground. But this was exacerbated by the success of the Navy’s international presence. Ralph Wyckoff, science attaché in the U.S. embassy in London, looked on piteously as scientists and delegates streaming into Britain for conferences bypassed his office entirely and headed straight for ONR London. While his office had only “one and a half” staff members—and those mere “boys,” in his estimation—ONR London

\begin{footnotesize}
\begin{enumerate}
\item Memorandum, Scott to MacNeill, February 2, 1946, RG227, Records of the Liaison Office, Entry 168, box 16, NARA.
\item Waterman, “Government Support of Research.”
\item Sapolsky, \textit{Science and the Navy}, 51.
\end{enumerate}
\end{footnotesize}
boasted 15 experts.\textsuperscript{171} It is not a stretch to say that the ONR literally continued the transatlantic exchange begun by Tizard.

One of the ONR’s most profound legacies was its reshaping of the U.S. postsecondary education system.

At the most basic level, the agency (following its predecessor, the OSRD) created a paradigm in which collegiate researchers turned to the military—and, by extension, the government—for resources and stability. But in an age when federal involvement in education was anathema, the ONR’s system also blazed a backdoor path to centralized education planning. Science advocates in this period frequently juxtaposed the European norm of government assistance to universities with the American manner of “look[ing] askance” at federal involvement.\textsuperscript{172} But with graduate students being spoken of in the bellicose language of “manpower” and “stockpiles,” the military now enjoyed the latitude to take advantage of Cold War anxieties in order to promulgate the OSRD and ONR contracting paradigms, R&D facilities construction, graduate education, and jointly-operated research programs. The result—not uncontroversially—was to bring universities into the military sphere of influence.

The ONR was ground zero for this centralization, thanks to both its influential contracting scheme and its active support for graduate student training.\textsuperscript{173} As Mina Rees explained, her goals as

\textsuperscript{171} Diary note, Raymond J. Seeger, London, August 18, 1954, box 1, Alan Waterman papers, LoC.
\textsuperscript{172} Kelly, Waterman, Ward, “Scientific Research and National Security.”
\textsuperscript{173} Sapolsky, \textit{Science and the Navy}, 44.
head of the ONR’s mathematics division were twofold: the doing of science and the creation of scientists. “I was trying to find out,” she recalled, “why did you give financial support to mathematics? Essentially it was time for mathematicians to do mathematics; and people—we needed more trained mathematicians. So those were the things that I was trying to buy for the people in mathematics who were doing interesting mathematics.”

Psychologist John T. Wilson was even more blunt in suggesting that the ONR’s interest in graduate training was a deliberate Trojan horse for federal participation in education. As he recounted, his cabal of “Young Turks” at the ONR sought to use its programs “as the mode, as the instrumentality through which the federal government would indeed broaden its base of support beyond the sciences across the whole higher education spectrum. . . We didn’t see how higher education would survive actually in the postwar period, unless the federal government moved in with some kind of support program, and the constitutional issue didn’t bother us at all.”

Finally, perhaps the ONR’s most significant legacy to the U.S. research and development world was its people. The office incubated a generation of researchers, educators, theorists, technocrats, and administrators, who would go on to bring the ideas formulated in the Navy to almost every corner of the U.S. technoscience establishment. Many of the original Bird Dogs, for

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[https://amhistory.si.edu/archives/AC0196_rees721020.pdf](https://amhistory.si.edu/archives/AC0196_rees721020.pdf)

175 Oral history interview, Frank Edmonson with John T. Wilson, University of Chicago, November 12, 1980, AURA History, Tape no. 37, RG307-Stack 103-Row 37-Cpt 15, carton 44, NARA.
instance, went on to set up copycat laboratories like Radlab, or went to private industry. In one notable example, Ralph Krause, the wartime liaison between Furer’s office, Radlab, and Harvard’s Radio Research Laboratory, moved on after the Navy to manage MIT’s Engineering Research Laboratory. He also served as a vice president of Raytheon Corporation. His Bird Dog counterpart, Tom Morrin, went to work for Raytheon as well. Both Krause and Morrin then joined Stanford Research Institute in Menlo Park, where they secured the Institute’s first contract—an ONR grant for the study of guayule rubber.\textsuperscript{176}

The largest such exodus was to the National Science Foundation, where ONR people, ideas, and values profoundly influenced the shape of U.S. civilian state-science in the coming decades. John T. Wilson, the first director of the NSF psychology program and later deputy director of the foundation itself (as well as president of the University of Chicago), felt that “without ONR NSF would not have survived, because it acted both as a conduit for professional staff, it set patterns that we just adapted, and also it really remained a very strong ally in many ways to some of us in NSF.”\textsuperscript{177}

The continuity of personnel started at the very top: When the time came for President Truman to name the first director of the NSF, he needed look no further than the ONR. As Jim Webb, the undersecretary of state and eventual head of NASA, remembered, the ONR “was a very forward looking body of people who had entered a vacuum and done a very good job of supporting basic research after the war when there wasn’t anybody else to do it. So it was the nearest thing within the government to the role set for the science foundation, and it’s not illogical you’d choose the man in

\textsuperscript{176} Gillmor, \textit{Fred Terman at Stanford}, p. 291.
\textsuperscript{177} Oral history interview, Edmonson with Wilson, November 12, 1980
Thus, in March 1951, Truman appointed the NSF’s first director: Alan Waterman.

Waterman swept in alongside a bevy of fellow ONR people. His deputy director was C.E. (“Gene”) Sunderlin, who came not just from the ONR, but specifically its transatlantic liaison division, ONR London. The foundation’s assistant director for scientific personnel and education was Harry C. Kelly, from the ONR. Its medical division director was Louis Levin, from the ONR. Its heads of biology were John Field, William V. Consolazio, and Wilson, all from the ONR. Its deputy director of mathematics and physical sciences was William E. Wright, from the ONR. Even Waterman’s administrative assistant, Doris McCarn, was from the ONR.

The head of the ONR’s mathematics department and eventually its deputy science director, Mina Rees, not only joined the NSF, she went on to the National Science Board (NSB), its controlling body. There she joined anthropologist Sophie Aberle and biochemist Gerty Cori as its first female members. Like so many of her fellow ONR expats, Rees’s story as a Bird Dog thoroughly reflected the transatlantic impact of the war on the U.S. technoscientific scene. As she put it, her time with the NDRC in the 1940s “gave me considerable understanding of the changes that were occurring in mathematics as a result of experiences in World War II,” and she received the King’s Medal of Great

179 Oral history interview, Edmonson with Wilson, November 12, 1980 7285.
181 Oral history interview, DuBridge and Fowler with Anderson and Goodstein, October 20, 1981.
182 Ibid.
Britain from George VI as a result of her wartime accomplishments. This experience, she believed, accounted for her effectiveness in building the ONR’s mathematics program from the ground up—and by extension, that of the NSF.183

Waterman, for his part, hoped that Rees’s pioneering arrival from the ONR would signal a robust gender progressivism in the new foundation. As he told the Washington Club in 1951, the country needed “womanpower” in science rather than just “manpower.” Lamenting the wanton shortage of women in U.S. physical sciences, but noting with optimism the growing number of woman researchers in DoD medical, chemical, and biological research programs, as well as the shining example of Rees, Waterman said, “One hopes that young women students as well as the men will be attracted to the scholarship and fellowship programs of the National Science Foundation, and that having acquired professional training they will be willing to put it to use during the critical years that appear to lie before us.”184

ONR émigrés to the NSF did not hesitate to build the new organ of state science in the image of their erstwhile agency. This was ably demonstrated by the fact that the NSF’s most dominant section in its first years was the Biological Sciences Division, thanks to its near-total domination by ONR expats. They brought with them bureaucratic experience, preexisting institutional relationships,

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Rockier—but equally telling about the importance of the ONR to the new foundation—was the experience of the Physical Sciences Division. As John Wilson recalled, many of the ONR’s physical scientists were pessimistic about the odds that the NSF would survive. As a result, many ONR people declined to move to the NSF. Instead of an existing ONR leader, then, Northwestern University’s Paul Klopsteg, a committed conservative who opposed state involvement in universities, was put in charge of Physical Sciences. In the estimation of Wilson, it was obvious that the NSF’s physical division was not matching up to its ONR forebear, and the program “really didn’t get off and running until Randall Robertson came over [from the ONR] and took the job as division director. And he settled the place down, began to recruit good program directors and really established the same kinds of program modes that were in existence over at ONR.”

In fact, in Wilson’s recounting, the NSF was marked in these early years by an ongoing and blatant divide of visions and of values between the young doctrinaires formerly of the ONR on one side, and the mostly conservative members of the National Science Board on the other. As he remembered, “There was a great deal of conservatism on the board, and we thought they weren’t nearly as bold as they should be, and we were always pushing and pushing and pushing to get things moving… The ONR background gave all of us in Bio a feeling of great independence and great nonlimitation. Because ONR, you know, the Navy really was very imaginative in what it allowed us to

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185 Oral history interview, Edmonson with Wilson, November 12, 1980.
186 Ibid.
do, and no holds barred. The thing was to get the job done. And we needed an infusion of red blood in the early days of the Foundation."\textsuperscript{187}

In their own view, then, the leaders of the ONR were the red blood of American technoscience in the early Cold War.

If the goal had been to convince the nation’s civilian scientists to work for the strengthening of U.S. power in a newly technological world, then, the ONR was wildly successful—even too successful, insofar as it created fiscal and programmatic dependency among scientists that the agency could not always shield from political and budgetary crises as the years went on. As a result, researchers eventually found themselves forced to interact with politicians and policymakers in Washington in a way they had not previously.

Scientists were obliged to circle their wagons around the ONR, for example, when the Truman administration attempted to slim its program during the 1947 defense cuts. While Vannevar Bush lobbied Secretary Forrestal to intervene personally on behalf of the agency, Karl Compton of MIT penned a letter arguing that since the ONR was a “new activity, established to meet a national need which was emphasized by the war and which is farsighted and far reaching in its implications,”

\textsuperscript{187} Ibid. Wilson elaborated further: “We looked on the board as a terribly conservative group of people. Again, the ex-ONR people looked at them as if—”Well, you know, you don’t know what the hell you’re doing… You’ve got to ask, you’ve got to make your case. Now, the difference was in ONR you had the admiral, and you had great individual responsibility in the programs of ONR. No one was looking over your shoulder telling you what you couldn’t do. You didn’t have to have advisory panels. You really were given great responsibility in the context of the Navy. And I’ve always thought this came out of the Navy’s small boats—if an ensign had charge of a boat, it was his responsibility. But there wasn’t the cautiousness that marked the National Science Board and the physical science group.”
cutting it would be “absurdly shortsighted.” In fact, he said, failure to expand its budget by $20 million would be “a real catastrophe and exceedingly difficult to justify.” Ultimately, the program’s appropriation was maintained, but the lesson was clear: Endowments from politicians with dissenting visions on the origins of national strength were very different from endowments from private benefactors, philanthropic foundations, and the Navy.

This lesson was borne out by subsequent history. As Harvey Sapolsky has detailed, the “golden age of academic science” in the United States—particularly in the vein of the liberal ONR—lasted only from 1946 to 1950. After that time, both the ONR and basic science in general became ‘noticed’ by politicians and policymakers looking to make easy budget cuts, with the result that the progressive Bird Dogs increasingly had to frame their programs in military terms. Particularly during the tight-fisted Eisenhower administration, ONR leaders found themselves forced to emphasize naval applications for academic science projects that actually had none—“painting them blue,” in their terminology. They learned to jettison potentially controversial or abstract pursuits, and to speak the language of defense whenever under naval or congressional audit. In this way, projects like “High-

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188 Letter, Karl Compton to Warren Weaver, December 24, 1946, box 26, Vannevar Bush papers, LoC; Memorandum, Karl T. Compton for Dr. John Steelman, “Budget of Office of Naval Research,” October 23, 1947, box 26, Vannevar Bush papers, LoC. Considering a concurrent proposal to institute universal military training for American men, Compton noted that such a program would be “definitely in lower priority of importance in comparison with a vigorous program of scientific research and development and the concurrent encouragement to the training of an increased group of scientists and engineers in those technological fields of greatest importance to our security and economy.”
power broadly tunable laser action in the ultraviolet spectrum” became “Weaponry—lasers for increased damage effectiveness.”189

Despite this tightening of pursestrings and narrowing of visions, however, the die was irreversibly cast for U.S. technoscience and the military’s role in it specifically. If anything, the Korean War and darkening defense posture of the country’s global vision only intensified the militarized rhetoric of science and power that the ONR, Bush, and others had espoused throughout the previous half-decade. By 1951 civilian agencies like the NACA were joining the Navy in raising alarm about the “serious deficiency of basic information” for the creation of radical new technologies. “We do not know how long the present period of tension will last,” a NACA report noted, “nor do we know what discoveries an enemy will make.”190

In short, the eminent journalist Raymond Swing had been right. In a broadcast to the nation in September 1946, Swing had warned of the ease with which the military might co-opt the vital national pursuits of research and development. As he predicted then, if the United States were to let the military “install itself as a guide to science as well as an agency to allocate facilities and personnel, and it will be hard to uproot them.”191 By the late 1950s, the roots seemed to be dug in permanently.

189 Sapolsky, Science and the Navy, 63
Science is what the military does

It didn’t have to turn out this way. After World War II there were many technoscience champions in the civilian world, many politicians convinced of the new global power ideology, many administrators with little appetite for allowing an expansion of the military’s ambit, any of whom might have taken the pivot of the war and applied it to a different kind of postwar statebuilding. But the political sclerosis, the unreadiness of the American state for its global role, the retrograde partisan environment, and the contingencies of a darkening geopolitical context on one hand, combined with the global vision, liberality of terms, lack of effective oversight, enormous resources, and political skill of a specific corner of the military on the other, made it so. This was not a sinister co-optation of free science, nor a deal with the devil at the bureaucratic crossroads, but rather a gradual and coproduced program between civilians and military personnel toward the buildup of U.S. global power and the underwriting of the scientific profession. And repeated Cold War crises taught these actors to speak in the language of national security—an idiom of “manpower” and “stockpiles”—to justify their programs.

The confluence of all these factors led Americans to think of science and technology in national security terms. As an urgent report by the Office of Defense Mobilization put it in July 1957, “The welfare of the United States, incomparably more than at any other time in its history, is dependent on new scientific knowledge for the welfare of its people, for the advancement of its economy and for its military strength. We advance through research or else our economy falters and our relative military strength diminishes. Research is a requisite for survival. Under these
circumstances, the Federal Government has no choice but to make sure that basic research is vigorously pushed.”¹⁹² These notions came to policymakers not from the NSF, not even from *Science: The Endless Frontier*, but from the active statebuilding and public advocacy of the military and civilian science promoters involved in this new state activity.

Did it have to be the military? By the mid-1950s a growing number of Americans seemed to think that it did. As the ODM report argued, “It is vitally important that the military services relate themselves intimately to scientific advance, be themselves scientifically advanced and au courant with every aspect of civilian science which is conceivably useful for military purposes.” Private industry and civilian academia simply did not face the same stakes. It was only the technologies of interest to the military, the ODM argued, that were “the most advanced of our time. Military weapons are constantly pushing on the frontiers of our scientific knowledge and thus are closely related to new advances in basic science… In no other field can one’s flank be turned quicker or a system be made as quickly obsolete by an advance in new knowledge.”¹⁹³

For this reason, it became a commonplace that science was what the military *did*. An NSF report in 1955 stated uncritically—even appreciatively—that “largely through the defense agencies, the Congress and the Executive Branches of the Government have granted liberal support to research and development in the physical sciences. Support in other areas, such as biological sciences, has

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¹⁹³ Ibid.
been very appreciable. The need for advancement in science is real.”194 And a memorandum by the White House’s Science Advisory Committee (SAC) noted approvingly that “the Department of Defense, following World War II, seemed to understand the role of research in the evolution and development of new weapons. The Service of greatest vision was the Navy, and its instrument was the Office of Naval Research. The research which the Office of Naval Research supported is now having its effect on Department of Defense developments.”195

This is not to say that this circumstance met with universal approbation. As historians have extensively documented, many scientists and university administrators resisted or resented military interest in their work—some on moral grounds, others in reaction to mounting pressure for applications and development as the 1950s drew on.196 In some cases this translated to political action, while in others a scheme of weak institutional divestment took place. Through organizational reassignment or physical relocation, ceremonial but porous walls went up in the 1950s between places like Argonne Laboratory and the University of Chicago, Lincoln Laboratory and MIT, the Lawrence Livermore Laboratory and the University of California, and the Applied Physics Laboratory and Johns Hopkins. But while these partitions reflected ongoing unease among academics about military work, the divisions were mostly ritual: the federal government and military went

unchecked in their continued ability to purchase both the scientific labor and institutional know-how of university communities.\textsuperscript{197}

In any case, a byproduct of the ‘securitization’ of technoscience in the public and policymaking eye was that the wide frontier of scientific inquiry—the futuristic breadth that had been so central to the ideology of the ONR and others—eventually became flattened into the geopolitics of prestige. That is, big, splashy technological developments quickly came to serve as imagined synecdoches for the nation’s overall strength in science and technology. This made the U.S. technoscience complex vulnerable to charges of global inferiority, while pressuring it to concentrate resources into symbolic developments, even if they were of little utility to the actual exercise of international power.

The result of this, by the mid- to late-1950s, was a crescendoing anxiety in both public and political spheres about the state of U.S. science and technology—and thus about the state of U.S. hegemony itself. In December 1956, the SAC warned that the United States was not sufficiently channeling its scientific activities towards fulfillment of its global responsibilities. The committee—chaired by the eminent physicist Isadore Rabi, another Radlab alumnus—was “convinced that this country’s technological strength is not being employed and developed in a manner required by the build-up of Soviet capabilities—with grave implications for our future security position. Even now it is questionable whether the U.S. enjoys meaningful technological superiority over the USSR.”

public needed to be made aware, it said, that “in this technological contest… long-term national survival may be at stake.”\(^{198}\)

The volume of state-supported research in the U.S. also seemed to be declining \textit{precisely} at the same time that intelligence suggested the USSR was stepping up its own commitments to technological development.\(^{199}\) The SAC fretted that the Department of Defense was decreasing its ONR-style frontier projects and was now “interpreting its mission too narrowly with respect to basic research; that it is taking the short-term attitude of immediate profit to the detriment of its long-range basic research responsibility.”\(^{200}\)

Further, technical advisors demanded that the United States exert scientific leadership abroad. As Lee DuBridge exhorted in 1956, “the enhancement of the U.S. technical strength by building and using the potentialities of the other free nations is of critical importance. International collaboration strengthens the individual efforts of all countries and also achieves the power of combined strength.” The “precious talents” of allied nations needed to be nurtured by the United States and “set free to serve the cause of the whole free world.”\(^{201}\)

To this end, President Eisenhower—hardly recognized as a friend to scientists during his time in the Oval Office—issued a public statement in April 1956 declaring that “world technological

\(^{198}\) Memorandum draft, D. Z. Beckler to Hon. Arthur S. Flemming, December 11, 1956, RG359, Subject Files, 1957-62 (MLR 1), box 18, NARA.

\(^{199}\) Letter, I.I. Rabi to Arthur S. Flemming, December 20, 1956, RG359, Subject Files, 1957-62 (MLR 1), box 18, NARA.


leadership carries the inherent responsibility before the world of using technology to help all peoples achieve a better life through the development of their resources for the good of all mankind.” Such leadership could come only through the buildup of American technoscientific power itself—that is, the nurturing of the nation’s “unique technological ability to use science for the strengthening of our country’s defense against aggression and for the application of our material resources to the improvement of human living.” It was a task made urgent by danger on the world stage. As the president cautioned, America’s “technological superiority is now seriously challenged by those who use science for aggression and conquest.”

Warnings like these were often precipitated by specific actions (or rumors about them) on the part of the Soviet Union. In Chapter 4, for example, we saw the shockwaves that the Harvard report *Soviet Professional Manpower*—and its claims about Moscow’s commitment to science education—instigated in the U.S. state. In a similar vein, the USSR’s announcement that it, like the United States, would launch a satellite into space in conjunction with the peaceful global cooperation project, the International Geophysical Year (IGY), set off a new round of handwringing among American policymakers. The SAC warned the White House that “failure by the U.S. to launch satellites successfully during the IGY in the light of this commitment would result in loss of U.S. scientific prestige that would be compounded by successful Soviet launching.”

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203 Letter, Dr. I.I. Rabi to Hon. Arthur S. Flemming, October 10, 1956, RG359, Subject Files, 1957-62 (MLR 1), box 18, NARA.
By the autumn of 1957, then, much had changed in the context of U.S. state science and technology. Possessed of a futuristic, globalist vision for a state-supported frontier of knowledge, a small cohort of technoscience champions in an obscure corner of the military largely determined the way American R&D would operate from then on, working mostly out of public or political view, and slouching ahead through political and bureaucratic setbacks, obstacles, and puzzles for more than a decade. In doing so, they carried forward the lessons learned and the possibilities imagined during the Second World War, all while deeply imprinted—sometimes consciously, sometimes not—with the legacy of the war-forged exchange with Britain and the bureaucratic apparatus that resulted from it. They constructed a particular brand of state power using an array of agencies, a diversity of funding sources, and a cunning method of contracting, in order to bring scientific labor, education, and ultimately, the manufacture of cutting-edge high technologies into the ambit of the state for the pursuit of national and international power. They constructed, in a word, the U.S. military-industrial complex.

At the same time, Americans by 1957 found themselves possessed of deep-seated anxiety about a geopolitical enemy with concealed motives and a demonstrated commitment to technological power—a power that seemed to erase natural U.S. security advantages in an existential way for the first time in history. In this context, wavering government commitments to the insatiable budgets of Big Science rendered the charge of “falling behind” in technoscientific superiority an easy one to make—and science advocates made it often. The learned behavior on the part of the ONR, NSF, and
others of framing peaceful scientific programs in military and security terms only served to exacerbate this apprehension further.

These two phenomena—the technoscientific light that had been illuminated under a bushel for the previous decade on the one hand, and heightening uncertainty about the foreordination of the United States’s position as a hegemon on the other—seemed ready to collide, almost primed to do so. Here, held in reserve, was both an ideology and a potential foreign policy praxis ready to be unleashed as an active projection of U.S. global power. The belief system inherent to it about American character; the grandiose promises it held of development and uplift; the seemingly easy solutions it harbored for thorny geostrategic problems; the bureaucratic mechanisms it demanded; the particular idioms it communicated to publics both at home and abroad—all of it had already been worked out by a generation of thinkers and doers whose creation was ripe to be debuted on the world stage.

A key intellectual, paradigmatic, and diplomatic resource was ready for use, if a major world event were to rattle U.S. leaders into drawing upon it.
Conclusion: The Fellow Traveler

Sputnik 1 launched on October 4, 1957, at 2:28 p.m. New York time. Five minutes later, its core engine shut down and, as it entered low earth orbit, it began transmitting a constant series of electronic chirps. This haunting sound—and the small Soviet craft it was radiating from—thrilled, mesmerized, and terrified the world sliding past underneath—the whole world—until the satellite burned up exactly three months later.

The Sputnik of U.S. historical imagination is often interpreted in timeworn terms of a rupture from nowhere; a machine above the garden; a sudden and intrusive perception of threat and vulnerability that spurred existential dread and an impulsive reappraisal of the American national security state. It is an achievement that is seen as sui generis—the “shock of the century,” as one telling has it.¹

But the U.S. response to the satellite was not to improvise a set of new ideas or shot-in-the-dark experimental programs. Rather, officials cast about for expertise, ideologies, and solutions already in the orbit of the state. Sputnik did cause anxiety and self-reflection across the government and public at large, to be sure, but that anxiety became channeled into elevation, rather than improvisation. Leaders and policymakers turned to programs and goals that had already been in

development, to worldviews that already been honed and packaged and translated and sculpted through nearly twenty years of political frustration and trial-and-error by an ardent group of technoscience thinkers. The Tizard Generation had woven a ready-to-wear hegemonic and diplomatic sheath for the United States by 1957; Sputnik finally provided the urgent impetus for putting it on display.

The country would thus respond to this symbolic challenge to its command of the global—and extraglobal—commons with science and technology. It would elevate the future-oriented technological globalism of the Tizard Generation to an active program of both domestic statebuilding and foreign projection. It would bolster existing infrastructures of research and development, and initiate new ones. It would draw from the collaborative impulses of scientific internationalism to seek bilateral and multilateral science and technology alliances. It would put science alongside other pillars of diplomatic expertise and strategy. It would spend untold billions of dollars on new technologies, both military and peaceful. It would dedicate resources to cultural diplomacy, world’s fairs, astronaut goodwill tours, exhibitions, and high-level summits extolling the benevolent technoscientific hegemony of the United States.

Despite their boldness and apparent novelty, however, none of these initiatives was new in the late 1950s. Nearly all of them had been cropping up in the reports, investigations, speeches, op-eds, and policy papers of technoscience champions, Bird Dogs, and Tizard Generation acolytes since the Second World War. And, as we have seen, in the intervening years many of them had been tried out across a variety of agencies, committees, and departments, to varying degrees of success.
Amid the complexities of midcentury geopolitics, technoscience was far from the only necessary pursuit of a global United States, of course. U.S. officials waged a multivariate program in pursuit of a variety of hegemonic goals—a preponderant grand strategy, however cobbled together it might have looked in practice. But regardless of other U.S. plans, the Soviet achievement was an act of hegemonic power projection that demanded a response in kind. As Dwight Eisenhower told the public at the time, “free men are meeting and will meet this challenge. Up to a point, this must be done on the Communists’ own terms—outmatching them in military power, general technological advances, and specialized education and research.”

Thus, while there would be other expressions of power abroad in the decade ahead—hot wars, covert operations, development initiatives, cultural diplomacy, propaganda—the Soviet consummation of the technoscientific discourses of the prior two decades meant that a key part of U.S. projection would now necessarily be based on the technological globalism espoused by certain actors in and around the state since the Second World War. The strategic political discourses that they had built surrounding this ideology seemed to be a panacea that, if followed, would address many, if not all, of the geopolitical challenges that lay ahead.

Sputnik was a simple 83-kilogram orb, but its crackling radio pings, its vigil in the night sky as it traced a steady path over all the peoples of the earth, was the quintessence of the sublime—awe-inducing, shocking, joyful, terrifying.

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2 Address, Dwight Eisenhower, "Our Future Security," Municipal Auditorium, Oklahoma City, OK, November 13, 1957, box 27, Alan Waterman papers, LoC.
Senator Lyndon Johnson was holding a barbeque at his ranch when the news of Sputnik broke; he led his guests on a nighttime walk by the river nearby, where he recalled suddenly feeling alienated from the night sky itself. Looking up, the future president found himself deeply affected by “the profound shock of realizing that it might be possible for another nation to achieve technological superiority over this great country of ours.” The next month, he organized a special subcommittee of the Senate Armed Services Committee, which held a marathon 27 days of hearings before issuing a preparedness report on America’s position vis-à-vis the Soviet Union. The document recommended 17 key research and organizational changes that the defense establishment should take to return to technological parity. More pertinently, it threw down the technoscientific gauntlet, issuing a sweeping declaration that “we have reached a stage of history where defense involves the total effort of a nation… There can be no adequate defense for the United States except in a reservoir of trained and educated minds.”

Behind the scenes, the White House pored over what the challenge meant and how the country should respond to it. The nation’s science elites put their heads together to hone the administration’s public front; what mattered now was that the American people understand the total nature of a technoscientific superpower conflict. This was a new field of battle that went beyond simple armaments—it was global, economic, and cultural, as well. The NSF’s Alan Waterman

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suggested that the president declare the USSR to be “out to capture the world by pre-eminence in science and technology—whether a gun is fired or not—by the economic strength which this policy will produce. This is a cold war in which we may be frozen out unless we show the determination of which an aroused free people are capable.”

As the presence of acolytes like Waterman in the White House’s brainstorming reveals, *Sputnik* was a moment for the Tizard Generation to say “I told you so.” Roy Johnson, the first director of the new Advanced Research Projects Agency (ARPA), censured the American people since World War II for always seeking “the quick, easy, and usually short term and expensive answers to national security crises. These crises would never have occurred had our nation faced up to the new technological and political conditions of our time on a continuing basis.” As world hegemon, the United States “had not done our total job, and the reasons for our failure go to the heart of the American matter: The people take international leadership for granted and complain if asked to devote more resources and planning to it.” For the prior fifteen years, he suggested, the critical groundwork for laying a technological base to keep up with the Soviets had been repeatedly quashed by a diffident Congress and a shallow public, and now American hegemony found itself in a technological crisis of power. As he put it, “politics back home and politics abroad often collide head on, and the vote prevails.”

For his part, the usually genial Waterman noted that it was “disturbing to see the extent of the efforts, in the wake of *Sputnik*, to pinpoint blame upon individuals, groups, or organizations. It

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5 Alan Waterman, "Comments on Speech," November 12, 1957, box 2, Alan Waterman papers, LoC.
indicates a blindness to some essential problems. If anything is evident, it is the fact that the Nation—all of us—should share the blame for failure to move more rapidly in altering our national attitude toward education, toward intellectual activity, toward increase of knowledge for the sake of knowledge.” Waterman had been a vanguard figure in the technoscientific ideology for the past decade, proselytizing to politicians, scientists, the public, the military, foreign audiences, heads of state—anyone who would listen—the reasons why America needed science for defense, strength, and power. Perhaps, he thought, Sputnik might finally make them answer the technoscientific bell. “We have been given warnings,” he argued. “Prominent educators, scientists, industrialists, Government officials, and public figures have been speaking out for some time. This topic has often been stressed in messages to the Congress… But our progress has been characteristically slow and gradual. We may be fortunate indeed if Sputnik provides means by which general public support of and participation in the solution of these problems can be rapidly achieved and thus save years of gradual evolution.”

The impact of the challenge on the United States was not only apparent in the domestic scene, either. Observers from the outside looked warily on the sudden vulnerability of the United States, but also saw potential new diplomatic opportunity. British prime minister Harold Macmillan, for example, wrote in his personal diary that Sputnik felt like another Pearl Harbor. “The American cocksureness is shaken,” he noted. The “President is under severe attack for first time [and] his

7 Alan Waterman, “Appendix A,” November 12, 1957, box 2, Alan Waterman papers, LoC.
policies are said to have failed everywhere. … The atmosphere is now such that almost anything might be decided, however revolutionary.”

If the event could be spoken of in this way—a Pearl Harbor-like threat—then it necessarily demanded that the president himself make a series of public addresses to reassure, inform, and rally the U.S. public, incorporating in particular the quick brainstorming of his science advisors. In doing so, Eisenhower walked a line between conceding that Soviets were “quite likely ahead in some missile and special areas,” as well as in satellites; condemning the USSR for funneling its resources into bellicosity and “expansionism” rather than the well-being of its people; reiterating that the United States remained strong and superior; listing the deadly technologies and advanced military developments the U.S. still wielded, as well as examples of their destructive capacity; calling for sweeping further state and public action; and attempting to maintain an eye on balanced budgets.

Cutting through these countervailing priorities, however, Eisenhower’s call to arms mainly signaled that the country’s response would be to enact a program of future-oriented technological globalism once and for all. The president expounded elegantly and at length on the need for a long-term frontier program of science and education to lead the world. With hegemony now yoked to

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Having solicited urgent advice from the government’s top-level science personnel, Eisenhower now articulated their critiques to the public—even the cultural ones decrying anti-intellectualism—and endorsed their programs. “According to my scientific friends,” he said, “one of our greatest, and most glaring deficiencies is the failure of us in this country to give high enough priority to scientific education and to the place of science in our national life.” The U.S. military was the best in the world, he insisted, the economy was strong, and the nation’s “spiritual strength” was resilient, but the thing the country most urgently lacked was the one thing a wealthy nation could not buy: time. As Eisenhower put it, “it takes time for a tree to grow, for an idea to become an accomplishment, and for a student to become a scientist. Time is a big factor in two longer-term problems: strengthening our scientific education and our basic research.”

This was an American president finally putting the full weight of the Oval Office behind the “endless frontier” doctrine, at least rhetorically. Eisenhower made no bones about the fact that a lack of commitment to a broad scientific program was, his counsellors told him, “for the American people the most critical problem of all. My scientific advisers place this problem above all other immediate tasks of producing missiles, of developing new techniques in the Armed Services.” Although U.S. basic research, “compared with any other country’s, is considerably greater in quantity and certainly

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10 Ibid.
11 Ibid.
12 Ibid.
equal in quality[, t]he warning lies in the fast rate of increase of the Soviet effort and their obvious determination to concentrate heavily on basic research. The world will witness future discoveries even more startling than that of nuclear fission. The question is: Will we be the ones to make them?”

Perhaps surprisingly for a president responding to a hegemony challenge, Eisenhower echoed the Tizard Generation’s diagnosis that many of the technologies of superpower had stemmed from transnational flows of knowledge and the “free international exchange of ideas” from abroad. He noted that there “instantly” came to mind the examples of Britain with jet engines, radar, and infrared rays; Germany with rockets, x-rays, and sulfa drugs; Italy with wireless telegraphy; France with radio; and Japan with magnetics. If the satellite launch made anything apparent, it was that the United States could no longer afford to go it alone in the realm of basic research.

It had been a long journey for U.S. R&D since the Tizard Mission had arrived in 1940, and here, nearly two decades later, the U.S. president responded to an unprecedented technological challenge by citing the transatlantic innovations of the Second World War, and calling for a state program to be hewed from its historical lessons.

Institution-building at home

In line with Eisenhower’s statement that “it takes time for a tree to grow,” many observers seeking the root cause of the crisis of scientific inferiority determined the true emergency to be the

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failure of the U.S. educational system. As we saw in Chapter 5, for some years brash young members of the ONR had attempted to conduct what they perceived as a guerilla incursion of federal influence into education; after Sputnik this became enshrined in law, thus reversing a century of localist ideology in schooling. In September 1958 Eisenhower signed the National Defense Education Act (NDEA), whose text censured the “imbalances in our educational programs which have led to an insufficient proportion of our population educated in science, mathematics, and modern foreign languages and trained in technology.” The act provided scholarships and fellowships for higher education and teacher training in science, mathematics, and languages, and disbursed hundreds of millions of dollars in student loans, training grants, and National Defense Fellowships.

As the NDEA example suggests, Sputnik finally inspired the U.S. Congress, so long the reverse salient in dedicating state resources to science and technology, to take quick and cavalier action. The NSF budget for the coming year was already in the books, but in March and then again in May 1958 Congress made sure to pass sizable supplemental appropriations to bolster its programs. The next round of budgeting, for fiscal year 1959, allocated the foundation $136 million, tripling the initial budget for the previous year at the stroke of a pen. By 1968 the foundation was receiving nearly $500 million, and by 1981 it was $1 billion. Indeed, in raw dollars, the NSF appropriation has

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never fallen substantially year-over-year since 1974.\footnote{“NSF Requests and Appropriations by Account: FY 1951-FY2020,” National Science Foundation, online resource, https://dellweb.bfa.nsf.gov/NSFRqstAppropHist/NSFRequestsandAppropriationsHistory.pdf} Despite the fact that Eisenhower continued pressing for fiscal cutbacks across the government through the end of his tenure, behind closed doors the NSF senior staff were confident that “relative to other Federal agencies, we are fortunate in the fact that science and scientific education is recognized as an increasingly important area of Federal activity.”\footnote{“NSF Senior Staff Meeting Notes,” June 24, 1959, RG307, 1 - Office of the Director, General Records, 1949-63, Waterman Subject Files, box 55, NARA.} Much had changed since eight years prior, when the agency’s first budget had been slashed 98 percent by an uninterested legislature.\footnote{See C3. Statement, Alan T. Waterman, August 19, 1951, Vannevar Bush papers, Box 117, LoC.}

Sputnik also gave renewed vigor to ardent cold warriors’ calls for technological investment and arms buildup. The launch of Sputnik led iconoclastic Democratic senator Henry “Scoop” Jackson, for example, to call for a “national week of shame and danger.” The crisis intensified security hawks’ efforts to revive the rollback doctrine of NSC-68, to develop intercontinental ballistic missiles, and to ramp up production of B-52 bombers. As hardliners’ hegemonic paranoias grew over the following two years, debate turned to a fictive “missile gap” with the USSR—one of Democrats’ signal issues for the 1960 election—which adhered to the techno-declinist line of reasoning of the post-Sputnik period by decrying that Eisenhower had allowed the U.S. to fall behind the Soviets technologically.\footnote{Robert Kaufman, \textit{Henry M. Jackson: A Life in Politics} (Seattle: University of Washington Press, 2000), 92. Jackson also co-sponsored the NDEA, as well as pushed for NATO to expand its science and technology activities.}

Meanwhile, serious debate roiled in Congress for the following five years about the fragmentation of federal R&D efforts and the need to harmonize the scientific activities of the
executive and legislative branches. Senator Hubert Humphrey spearheaded ongoing efforts to create a new cabinet division, the Department of Science and Technology, which would absorb the National Science Foundation, Patent Office, Office of Technical Services, Bureau of Standards, Atomic Energy Commission, NASA, and parts of the Smithsonian Institution. The proposal was polarizing, with both urgent support and ardent opposition, and commissions continued investigating its ramifications through 1962. An alternate coordination plan, put forward by Senator Jackson, succeeded in adding an Office of Science and Technology (OST) to the executive branch, a body that became particularly salient to the formulation of annual budgets and the determination of R&D projects to be prioritized for national purposes.22

The government also waged scientific reforms away from Capitol Hill. The State Department quickly reestablished its science advisor and attaché program, this time making sure that those offices reported directly to the Secretary of State. With a proliferation of intergovernmental technoscience organizations, new development and technodiplomacy initiatives, bilateral and multilateral research programs, propaganda efforts, and international atomic and resource negotiations, it was now at last recognized that the global position of the United States required robust and active input and energy among the diplomatic corps in scientific matters. As one department report put it in 1962, “we depend on American scientific and technological achievement more than ever before for the realization of foreign policy objectives.” It was now “trite” to acknowledge the foreign relations

impacts of the “revolutions in communications, transportation, health, and a host of other fields.” Thus the primary question that remained was, “How are the changes of tomorrow and of the day after going to alter further our international environment, and what should we be doing now to prepare for them?”

The Department of Defense responded to Sputnik by doubling down on its existing infrastructure of R&D, establishing a senior policymaking position, the Director of Defense Research and Engineering, as well as Assistant Secretaries for Research and Development in each service. Here, too, the “endless frontier” emphasis on basic science percolated into top-line planning. The department, for example, placed an invigorated stress on basic biological research under the premise that revolutionary new “opportunities to control and modify biological processes may provide entirely new alternatives to classical concepts of defense and thus help to overcome a potential stalemate in physical weaponry.”

Despite these changes, this period nevertheless saw intense congressional inquiries into why the Pentagon was not doing more to support research and development, despite the fact that well over half of all federal science activity to that point had been performed by under the auspices of the

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23 President’s Science Advisory Committee, “International Science Panel: Science and Technology in the Department of State,” February 27, 1962, RG59, Bureau of Scientific and Technological Affairs, Central Files, Entry 3008D, box 3, NARA.

24 Letter, Alan Waterman to Hon. Henry M. Jackson, February 8, 1960, RG307, 4 - NSF Historian file, entry UP-UP-1, stack 103, row 37, cpt 15, container 21, NARA.

Defense Department. 26 Amid this hand-wringing, the military establishment took its response to
Sputnik a step further by creating the Advanced Research Projects Agency (ARPA). The new agency
was designed as a central clearinghouse whose responsibility was to investigate ambitious and far-rang-
ing frontier research, especially in space, and to bypass still-fraught intra-service rivalries. As the
national space program was reorganized, ARPA pivoted to pursue a considerable variety of other
experimental projects, from advanced military hardware to computing to artificial intelligence.

In ARPA we see a dramatic validation of the philosophy of the Office of Naval Research. The
new agency was intended to pursue research at the far-flung frontiers of scientific and technological
fields, providing eye-popping funds to projects that the services would not fund, either due to
financial unfeasibility or lack of apparent military relevance. Inheriting as it did the government’s
assorted space programs, ARPA’s first appropriation was an astounding $540 million, and, just like
the early ONR, the agency had essentially carte blanche to distribute it with minimal oversight. 27 As
eventual director Stephan Lukasik recalled, “ARPA decided who to let a contract to, and said, ‘Give
them $300,000,’ and that was all there was to it. There was a program management office that in a
sort of perfunctory way generated a piece of paper so that if anyone said, ‘Why did you give $300,000
to X?’ the answer was well, there’s this piece of paper—a very short paragraph—excellence of work
and unique capabilities and special facilities, and blah, blah, and we’d write some sort of pro forma

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Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House
27 Figure derived from Army, Navy, Air Force Journal, vol. 97, issues 1-26 (Washington, D.C.: Army and Navy
thing and that was all that was needed.”28 Like the ONR’s Bird Dogs, it was the idea of the broad frontier that interested ARPA’s leaders. As one agency history noted, ARPA had been “spawned in an atmosphere that equated basic research with military security.” The combination of broad-frontier ideology, absurd appropriations, minimal oversight, and a frontier approach linked the agency directly with its Tizard Generation predecessors. As Paul Edwards noted, “In effect, ARPA reincarnated the World War II OSRD.”29

Of course, as the initial ARPA mandate indicated, the nature of a satellite threat made technological globalism so extraterritorial as to be extraterrestrial, and the obvious response was to seek supremacy—or at least parity—in space. In the first three months of 1958, three separate space subcommittees were set up in Congress, the investigations of which yielded the National Aeronautics and Space Act, transferring and expanding the programs of the long-serving NACA into a new NASA, in the process swaddling U.S. space and rocketry programs in a peaceful, civilian, diplomatic garb.30 In pressing for the act, Eisenhower noted that taking this step would urgently fulfill the goals of knowledge accumulation, military necessity, and national prestige, factors which now had “such a direct bearing on the future progress as well as on the security of our Nation that an imaginative and well-conceived space program must be given high priority.”31

But for all its rhetoric, the White House’s own response was ultimately administrative. The Science Advisory Committee, laboring since 1951 under the Office of Defense Mobilization, was now reconstituted as the President’s Science Advisory Committee (PSAC), with an active and direct line to the Oval Office. Its new purpose, as Eisenhower put it, was to organize and formalize scientific policy “so that no gap can occur,” as well as to advise the White House in order “to make it possible for me, personally, whenever there appears to be any unnecessary delay in our development system, to act promptly and decisively.” The director of the PSAC, also filling the new post of Special Assistant to the President for Science and Technology, was MIT president James Killian, the esteemed administrator who had helped to manage Radlab during World War II. Indeed, the list of Killian’s successors through 1970 drew heavily from the Tizard Generation’s list of wartime exchange luminaries. There was OSRD alumnus and Manhattan Project division leader George Kistiakowsky, who was sent to Britain several times during the war to work with eminent scientists there. There was Radlab alumnus Jerome Weisner. There was Los Alamos group leader Donald Hornig. And there was Radlab founding director Lee DuBridge, among others.

While the PSAC was a personal advisory body to the president, the nation’s R&D activities still needed coordinating on a broad level. To resolve this, the PSAC in 1959 secured the creation of a “Little Cabinet for science,” which would coordinate and streamline government research and grants, as well as annually update a three-year national plan for federal science. This body was inaugurated as

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33 For more on the PSAC and FCST, see Wang, In Sputnik’s Shadow.
the Federal Council for Science and Technology (FCST), and it, too, came under the leadership of Killian and his war-seasoned colleagues.34

The continuing presence and influence of this generation in the White House, in Congress, and in the defense establishment was crucial, because it gave their ideas the most prominent airing that they had enjoyed since the Second World War. We can see the clear influence of these “scientific friends” of the president in the administrative rollout of the following decade—its methods of organizations, its justifications, and its conceptions of the evolution of the world. We can also see its ideas flickering on across the machinery of the state—the FCST, for example, reported to the National Security Council that “the national safety and welfare depend increasingly upon a healthy, advancing technology. Technology can advance only if there is a constant flow of new ideas produced by basic research. Adequate support and wise administration of basic research programs are therefore important to the strength of science and technology.”35 These words were written in 1960, but they could have come from the ONR in 1950 or the RDB in 1945. The genealogy of ideas dating to the Second World War had now, for a time, attained administrative supremacy.

But the changes in the late 1950s were not only bureaucratic. This was, fundamentally, the consummation of a way of thinking, one that had been honed for years and which now bore a streamlined and compelling vocabulary. Everywhere in the government machinery we look, we see

34 Wang, In Sputnik’s Shadow, p. 162.
new sectors of the state, new actors, new diplomats, new representatives of U.S. power abroad, together articulating the discourses of technological globalism, repeating the newly validated mantras of the scientific frontier and of the new material reality—and, most importantly, the need for American leadership in it. The vision had always mixed a breadth of basic science, state action, global projection, and new public appreciation for science and technology, but now a critical mass of influential people were saying it. They were pushing for the policies and mindsets that would make the United States a true and committed technological hegemon.

This was a time for the Tizard Generation to take something of a victory lap. From his crow’s nest at the now-mushrooming NSF, Alan Waterman noted that “the future of the Nation in no small measure rests on the continued acceleration and advancement of science... There are few, if any, areas of endeavor as important to the future vitality and strength of the nation as is basic research.”

That a figure like Waterman would extol the virtues of basic science to the nation’s power was predictable. But such language quickly became endemic across the state. Unlike the diffidence of a decade prior, the diplomatic corps was now adopting the tenets of technological globalism across a range of official activities. This was not only a matter of funding scientists in universities at home, they understood, but projecting scientific strength abroad—to use this seemingly innate resource, that is, to make an impressionistic impact on enemies, allies, and the nonaligned alike. As one State Department circular noted in 1963, “science and its fruits have become one of the most compelling and dynamic forces affecting the power of the nation. Coupling this with the great scientific strength

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of the U.S. leads to a somewhat different aspect of the relationship between science and foreign policy: the opportunity for this country to relate its scientific strength and capabilities directly to important foreign policy objectives.”

But the realization of those objectives could only come through expertise. Just as in the immediate aftermath of the Second World War—when foreign policymakers scrambled to absorb whatever fragments of world expertise, area studies, and on-the-ground international knowledge they could muster after years of neglect—now at the dawn of the 1960s they scrambled to bring scientists into the diplomatic machinery and bring the diplomats up to speed with the latest directions of R&D. In 1964, a report for the State Department’s Foreign Service Institute argued that science represented the crucial third pillar in the foreign affairs structure. As the report put it, the nation’s diplomatic service needed “competence in ‘science affairs,’ to make it roughly parallel to the familiar categories of economic affairs and political affairs. The need stems from the conviction that a new kind of competence must now be intimately involved in the details of policy formulation and execution in many substantive foreign policy areas.”

Of course, projection was only one side of the coin. As the FCST told the NSC, power could only be projected if there was true technoscientific strength underlying it. In a fierce global competition, warned the committee, “the United States may fall behind unless it succeeds in

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37 State Department SCI, “Scientific Development and Foreign Policy: Purposes and Scope of Proposed Conference,” June 18, 1963, RG59, Central Foreign Policy Files, Subject-Numeric files, 1963, SCI-1 to SCI-3, stack 250, box 4165, NARA.

communicating to others the true image of its scientific and technological strength. Although projecting an image of strength is important, the nation’s actual strength in science and technology must remain the primary consideration. Only actual strength, in fact, can be genuinely convincing.”

Using language that had been consistently honed since the days of S:EF, the council underscored that the buildup of such strength rested on a state-supported frontier of basic science. Only “an actively supported program of basic scientific inquiry can produce the new ideas necessary to a healthy science and technology, and can thereby also provide the basis of an effective image.”39

The dialectic between core domestic strength and projected international power did not only find purchase among state actors, either. A 1961 editorial from Fortune magazine, for example, soberly proposed that the government dedicate a billion dollars a year to a new “Office of Harebrained Ideas,” an “independent, freewheeling agency” that would bridge the gap between basic research and present technological achievement, in order for the United States to truly explore “the unorthodox, the radical, the creative.” A billion dollars for such wooly, abstract goals was a risky proposition, but “it is about the only major hope for staying ahead in a world of swift technological change that is remaking the international landscape.”40

Did an Office of Harebrained Ideas not sound like the ONR? Did its proposed budget sound so far-fetched when we consider the $540 million appropriation to ARPA? Did the pursuit of the unorthodox, the radical, the creative, not form the cornerstone of a particular brand of thinking about the nature of American power that had been growing and evolving since 1940? The United

39 FCST, "Strengthening the Free World Position in Science and Technology."
States had rarely in its history been a country whose state easily disbursed money for new and untried programs, particularly ones with no immediately definable deliverables. Yet here, in the late 1950s and early 1960s, resources flowed by the billions to Big Science, High Technology, and all the “amazing and amusing and practical and military” national benefits they seemed to promise.\textsuperscript{41} What is remarkable when considering the Office of Harebrained Ideas proposal is that, by the time it was published in 1961, it \textit{didn’t} seem particularly far-fetched. Far from it.

The country was finally being forced to act, then, to make good on the technoscientific promises of the Second World War, and it seemed like it might actually work to the Tizard Generation’s satisfaction this time. Technological globalism was on track to stabilize U.S. power in the world. As ARPA’s Johnson put it, the late 1950s represented the “technological birth of a new dimension in the politico-strategic concepts of this world.”\textsuperscript{42} And as Waterman echoed to an audience in Glasgow, “it is apparent that, with remarkable unanimity, all countries of the world have decided that their future lies in their development of science and technology.”\textsuperscript{43}

All of this accorded with the rise of the nebulous notion of “prestige” as a measuring stick for power and a catalyst for state programs during the 1950s. As Kenneth Osgood and others have argued, the Eisenhower administration began to wage a “total Cold War” in which psychological, cultural, and ideological warfare—filtered through the praxis of propaganda—represented the fourth

\textsuperscript{41} Manzione, “‘Amusing and Amazing and Practical and Military.’
\textsuperscript{42} Roy W. Johnson, “Higher Education and Advanced Research.”
\textsuperscript{43} Address, Alan T. Waterman, British Association for the Advancement of Science, Glasgow, September 2, 1958, box 12, Alan Waterman papers, LoC.
pillar of the global struggle, alongside military, economic, and political confrontation. Particularly after Sputnik, science, technology, education, and their contribution to the general prestige of the nation came to the fore.44

The CIA, for its part, built up by 1961 an Office of Scientific Information, comprised of 50 professionals. These agents processed intelligence and data on foreign science activities, interviewed U.S. scientists, and liaised with research institutions. In the view of the NSF, particularly in the case of Soviet activities, the OSI was “obviously the most elaborate and complete source of information” then available on foreign science.45

Of course, it is important not to lay the rollout of these complex programs—nor a decade of diplomatic strategy—on a single satellite launch—the Soviets’ scientific threat to American global interests was not limited to merely observing the world from above. As we have seen, perceptions of technoscientific threats from Moscow had been steadily growing by the mid-1950s, and indeed, U.S. science elites worried less that Moscow would actually succeed in remaking the world in its technological image, than that it would succeed in exploiting the beneficent ideology of science to win allies and endanger the U.S. position in the Global South. U.S. science administrators in the FCST nervously wrote in 1960 that “the Soviet Union uses science and technology as major instruments of international policy. It exploits their propaganda value. It uses them to exact political commitments of various sorts from foreign nations. It emphasizes the indoctrination by-products of

44 Wang, In Sputnik’s Shadow, p13; and Kenneth Osgood, Total Cold War: Eisenhower’s Secret Propaganda Battle at Home and Abroad (Lawrence, KS: University Press of Kansas, 2006).
technical assistance.” The United States, by contrast, has “not taken full advantage of the opportunities available to it in this sphere.”

One of the primary American responses to the Soviet challenge in the developing world, then, was to elevate the ideas of technological globalism into a scheme of developmental and diplomatic rhetoric, projection, and propaganda. The FCST proposed that the U.S. make a concerted effort to project its scientific and technological power via “increased emphasis on programs having considerable psychological impact,” as opposed to just scientific merit. Even within such programs, “decisions among technically comparable objectives may legitimately be made partly on the basis of psychological considerations.” The end goal was not necessarily to bolster science, but to improve the global image of the country by improving “ways of informing the world about the scope and nature of U.S. science and technology,” including new international scientific conferences, exhibitions and fairs, and educational and academic exchanges.

Of course, the use of space in the aftermath of Sputnik to elevate the Tizard Generation’s overall technoscientific globalist program became a double-edged sword. While the ideal manifestation of their doctrine was to pursue a broad-based frontier approach to science and a global deployment of technology, the fetishization of splashy high technology as the ultimate validation of the creed invited an overemphasis—in terms of both public imagination and national resources—on certain kinds of ‘victories.’ “To Race or Not to Race?,” a secret discussion paper produced two years

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46 FCST, “Strengthening the Free World Position in Science and Technology.”
47 Ibid.
after Sputnik—by which time the U.S. had made 34 launch attempts, of which 13 were successful—
fretted that by responding to rockets with rockets, the United States was essentially violating the age-
old military maxim not to fight on the battlefield of the enemy’s choosing. The USSR had made clear
to the world that it excelled in rocketry, and U.S. responses in kind had made the whole program
“become a battle for world opinion on the basis of spectacular rather than scientific gains… As space
loses its novelty for the less-than-informed masses, very few other such feats will impress their
imagination.” It would be better, therefore, to double down on the Tizard Generation ideology,
emphasizing that it was the American collection of new and vital scientific information from its space
vehicles, rather than its impressive payloads or hardware, that signaled the country’s “general
technological superiority.”

The budding space race, then, was a perversion of the technological globalist ideology, but
like the anti-scientific Red Scare before it, it nevertheless validated the technological vision of power
that underlay it.

Shockwaves across the world

Of course, the United States did not construct its brand of technological hegemony in a
vacuum. The race for a knowledge- and materiality-based international order was a global one, and
the reaction to it was equally global. If technodiplomacy was matter of economic, military, strategic,

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box 19, NARA.
and cultural competition, no country or bloc, north or south, could afford to remain idle while the
rest of the world scrambled to keep up.

Almost immediately after Sputnik, capitalist states scrambled to find mutual solidarity, joint
responses, and the comfort of a shared sense of threat and resolve. One of the most telling of these
initial actions was that of Britain. Six days after Sputnik, prime minister Harold Macmillan sent a
personal message to Eisenhower in which, although he did not use the words, he essentially proposed
a renewal of the Tizard exchange. An official visit to Washington was hastily arranged, using
technological partnership as a potential diplomatic lever to renewed the transatlantic alliance, just as
Whitehall had done in 1940. Anglo-American relations had been deteriorating—most notably with
the recent Suez Crisis—but the Soviet shock, combined with the known achievements of Britain in
certain technical fields, made the Americans receptive to a tighter alliance.\textsuperscript{49} President and prime
minister quickly signed a “Declaration of Common Purpose,” reversing the atomic secrecy stalemate
that had prevailed between them since the passage of the 1946 McMahon Act. The newly-close
partners committed to shared R&D in the future, and Britain managed to plug into U.S. hegemonic
activities more broadly.\textsuperscript{50}

As the Anglo-American example shows, one of the first impulses of leaders in both the U.S.
and in U.S.-aligned states was to reinforce their efforts at collaborative technoscientific diplomacy.
Scientific internationalism itself was hardly new; scientists had been organizing themselves across


\textsuperscript{50} Ashton, “Harold Macmillan and the ‘Golden Days’ of Anglo-American Relations Revisited.”
borders for centuries, most prominently through the International Council of Scientific Unions (ICSU), an NGO comprised of representatives from national academies and international delegates, constituted in 1931. What was new in the post-World War II period, and what accelerated in the late 1950s, was inter-governmental scientific organizations, a mass elevation of R&D exchange to worldwide diplomatic standing. The ensuing landscape of state-to-state scientific exchange organizations was unprecedented in world diplomatic history.

The effort began with the UN, under whose aegis a variety of multilateral science and technology organizations were formed, including the Food and Agricultural Organization (1945), UNESCO (1946), the World Health Organization (1946), and the World Meteorological Organization (1951). The International Atomic Energy Agency (IAEA) was established in July 1957, albeit technically separate from the UN.51 The UN’s technoscientific purview began to become more blunt and more targeted between 1961 and 1964, when it held major conferences on the impacts of science and technology on development, particularly in the Global South. In 1964 this initiative was enshrined in the UN Advisory Committee on the Application of Science and Technology to Development (ACAST). In 1966 it rejected piecemeal approaches to development, and instead called for a World Plan of Action, ultimately published in 1971.52

The U.S. followed suit in forging bilateral and regional science links with Global South states, inaugurating joint research institutes, NSF summer teaching institutes, and other programs through

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organs like the Organization of American States. Science advisors’ beliefs in this regard were quickly bolstered by eminent social scientists. In 1957 the Committee on Economic Development asked a group of fifty scholars and policy leaders to submit essays on “The most important economic problem to be faced by the United States in the next twenty years,” and a majority of them agreed that the single greatest issue would be “the problem of the underdeveloped nations of the free world.” Development theorists Walt Rostow and Max Millikan called for an additional $2 billion in foreign aid, and the NSF’s Waterman pleaded for improvements to the U.S.’s own education system in order to meet the challenge of international development.53

Of course, scientists and developmentalists had suggested such measures throughout the previous decade. What changed after Sputnik was that their recommendations began to find purchase at the highest levels. By 1962, for example, the PSAC had concluded that initiatives abroad as varied as the foreign aid program, international health programs, and “information efforts to project a U.S. ‘image,’… all rely on using the excellence of American science as a basis for international operations where the political objectives are dominant.”[6]54

International institution-building was not only about development, of course, nor was it only U.S.-centric. For example, the Organisation for European Economic Co-operation (OEEC), which had administered Marshall Plan aid to Europe, responded to Sputnik by setting up an Office of

53 Address, Alan Waterman, “America’s Human Resources to Meet the Scientific Challenge,” Yale University, February 3, 1958, box 47, Alan Waterman papers, LoC.
54 PSAC, “International Science Panel: Science and Technology in the Department of State.”
Scientific and Technical Personnel focused on education. In 1961 the umbrella organization was reconstituted as the Organisation for Economic Co-Operation and Development (OECD), and pivoted to a new focus on studying and fostering national “policies for science”—planning, determination of priorities, allocation of resources, and studying the complex connections between R&D, education, management, and economic growth—as well as “science for policy”—the application of research, science, and technology to the attainment of national and regional goals, including in agriculture, industry, and foreign affairs. As an entity somewhat independent from the bipolarity paradigm of the Cold War United States, the OEEC-OECD was also able to respond to Sputnik by sending investigators to Moscow and Kiev to study the bases of Soviet technological development directly.55

More targeted blocs began exploring collective technoscientific action, as well. If these were narrower than the global scale the UN, they were not necessarily less ambitious. NATO, for example, accelerated its departure from being strictly a defense alliance after Sputnik. In December 1957, it convened a special meeting of heads of government in its Paris headquarters to negotiate a number of sprawling science-based agreements, reached under the heavy lobbying of the U.S. delegation. A NATO Science Committee comprised of high-level representatives from each country was established, and indeed, was given such extraordinarily broad powers that it could scarcely begin to exercise them all. A Science Advisor post was also created, filled first by Harvard atomic physicist

Norman F. Ramsey, Jr. This position was placed at such a high level in the organization that Ramsey effectively became the assistant Secretary General of the whole alliance.\textsuperscript{56}

Gesturing at these changes, President Eisenhower noted that “All expressed approval of [NATO’s] growing capability to secure cooperation among member nations in political, economic, and scientific areas, as a supplement to its work in the security field.”\textsuperscript{57} By 1966, this language of “supplementing” had evolved significantly. Off the record, deputy secretary general James Roberts conceded that NATO as a whole “seemed to be shifting from alliance based on military necessity to one which will include greater emphasis on scientific and social requirements of allies”—to improve in a modern and holistic way, that is, the “base of Atlantic unity.”\textsuperscript{58}

Under Ramsey—a Radlab alumnus and longtime U.S. state-science organizer—and his successors, the NATO science program tried to implement programs distinctly inflected with Tizard Generation ideas, focusing on education programs, summer institutes, and grants for free and open basic research that would “add to NATO’s dignity” and convince the world that it was not simply a bellicose defense organization.\textsuperscript{59} Some insiders compared this metamorphosis specifically to the

\textsuperscript{56} W.A. Nierenburg, “Project of Report on NATO Science Activities,” December 3, 1963, RG59, Bureau of Scientific and Technological Affairs, Central Files, entry 3008E, box 1, NARA.

\textsuperscript{57} Address, Alan Waterman, “Science and International Affairs,” Williamsburg, Virginia, September 14, 1959, box 47, Alan Waterman papers, LoC.

\textsuperscript{58} Telegram, “NATO Science Committee Meeting Lisbon,” October 13, 1966, RG59, Central Foreign Policy Files, Subject-Numeric files, 1964-66. Entry 1132A, 59 250-70-18-4, container 3075, NARA.

experience of ONR and the Bird Dogs; as one State Department circular put it, “the anachronism of a
defense alliance furthering pure science, competently and pragmatically, is somewhat analogous to
the state, a short time ago, of the U.S. Office of Naval Research.” In fact, the ONR was such an
effective example that it even seemed possible that NATO represented a natural seat of scientific
inquiry. As another State Department report posited, the ONR and NATO cases perhaps simply
revealed the “normal pattern” of how large technoscientific complexes came about in the modern
world: Massive initial support from military interests, thus giving more specialized civilian and
peacetime agencies time to develop and take the reins. For this reason, the report concluded, “it is
important to recognize the necessity for maintaining a strong NATO program in the sciences as is the
case with the United States military programs, even while stressing the necessity for the development
and furthering of these programs within the other international organizations.” In this formulation,
as in so many others, the Bird Dog ethos seemed to be universalizable at an international scale.

Looking more narrowly at Western Europe, we see that science and technology were moving
ever closer to central status in relations between states. As Dominique Pestre and John Krige have
argued, the European Organization for Nuclear Research (CERN) was established in the early 1950s
by European states seeking intracontinental development, technoscientific parity across the English

60 Memorandum, Eugene G. Kovach to Dr. Rollefson, “Meeting to Develop US Position on NATO’s Science
Program” November 5, 1963, RG59, Bureau of Scientific and Technological Affairs, Central Files, Entry 3008E, box
1, NARA.
61 Nierenburg, “Project of Report on NATO Science Activities.”
Channel and across the Atlantic, and postwar restoration of geopolitical power.\textsuperscript{62} Similarly, the creation of EURATOM in 1958 represented a specific and deliberate avenue for European integration. Indeed, the three stable communities of regional unity in the coming decades were the European Coal and Steel Community (itself concerned with fostering scientific research), the European Economic Community, and EURATOM itself. As Thomas Misa, Johan Schot, and others have argued, the circulation of scientific and technological artefacts, systems, and knowledge, as well as the unification and deunification of infrastructures, represented “hidden integration” and an essential—if fraught—component in the long march toward European union. In this reading, technological processes “carried, shaped, flagged, and helped to maintain a sense of Europeanness, bringing out tensions in Europe and tensions about Europe.”\textsuperscript{63}

Those tensions are important to the story, since the elevation of science and technology to high diplomacy was never just a matter of cooperation and collaboration. In fact, its primary valence was one of competition, suspicion, one-upsmanship, and anxiety—and often that suspicion was directed towards Washington. This was the price the United States paid for elevating technological globalism to a central plank of its diplomatic strategy. The world could not help but squint in the glow of the disproportionate command the U.S. was showing off—the American state, for example, 


\textsuperscript{63} Thomas Misa and Johan Schot, eds., “Inventing Europe: Technology and the Hidden Integration of Europe,” \textit{History & Technology}, vol. 21, no. 1 (March 2005).
was spending more on space alone than the *entire* UK defense budget. Projections of progressive material leadership and omnipotence invited disappointment when the U.S. failed to live up to beneficent expectations, and invited resentment when the U.S. seemed to be smothering the competitive abilities of its allies. For these reasons, by the mid-1960s, technological globalism went from being an image the U.S. actively sought to a sensitive tightrope walk, requiring both carefully packaged promotion and deft diplomatic crisis management to sustain.

For example, in the early 1960s Britain and then other European countries began to agonize over a “brain drain” to the United States, where the laboratories, standards of living, intensity and concentration of research, and salaries for young scientists were all far in advance of those of midcentury Western Europe. As one memorandum from a European embassy put it, the “brain drain” notion “caused a long-smouldering feeling within the scientific community to burst into flame.” Britain, for one, resented the stifling scale of U.S. industrial competition in sectors like aviation. As one British observer put it, “Britain is Greece to America’s Rome… American laboratories are making the running in very many of the most lively fields of scientific progress… The enormous, wealthy campuses of Stanford, Berkeley, the Massachusetts Institute of Technology, Harvard and others are not only rolling in dollars—they are fizzing with intellectual excitement.”

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Similarly, German scientists built up a laundry list of resentments dating all the way back to the intellectual looting of the postwar Paperclip program. German newspapers furiously circulated rumors of “talent hunts” and “recruitment drives” by U.S. firms and universities.67

More broadly, a rising belief among European diplomats and heads of state in the 1960s in the existence of a “technological gap” with the United States in areas like nuclear power, automation, space, telecommunications, electronics, and computing stimulated unprecedented efforts toward a united European answer to American domination. This resulted in new multilateral avenues of both cooperation—such as the European Space Research Organization (ESRO) and the Concorde supersonic airliner project—and rivalry—such as the nationally-focused Centre National d’Etudes Spatiales (CNES) in France and the Ministry of Technology in Britain. These programs were conducted with eyes on both national geopolitical power vis-à-vis the region and regional power vis-à-vis the United States, kindled by an anti-American nationalism that the permanent secretary of the British Ministry of Technology characterized as being marked by “emotional intensity and total irrationality.”68

Of course, as the object of a flattened diplomatic projection, technology did not always truly represent the root of a grave economic disparity as policymakers often believed. In fact, ‘technology’ was often a fetishized avatar onto which more intractable questions about nationalism,

67 Airgram, AmEmbassy Bonn to Department of State, “Talent Hunts and Recruitment Drives by U.S. Concerns Elicit German Reaction” March 1, 1963, RG59, Central Foreign Policy Files, Subject-Numeric files, 1963, SCI-1 to SCI-3, stack 250, box 4175, NARA.
postcolonialism, economic output, and prestige were projected by foreign ministries and intergovernmental organizations in a rapidly-changing world. But that was the cost of elevating technology to primary status in the competition for global power. The truth of it did not always matter as much as the perception. As a result, technological fixations ultimately played an important role in drafting the geopolitical, ideological, bureaucratic, and experiential blueprints for closer European unification.

Like many of the most attractive ideologies, technological globalism before 1957 was as-yet largely unproven, and possibly unprovable. The Tizard Generation had never entirely enjoyed the budgets, resources, policymaking attention, or cultural cachet that they had called for, so their totalizing vision could not credibly be deemed unworkable. In the absence of hard studies, and in light of spectacles like Sputnik, the association of national power with basic science, an “endless frontier,” technological command, and technoscientific projection came to seem rational and logical. As ARPA’s Johnson put it, “Here in the middle of the 20th Century America has achieved an industrial and technological stature which has given it a primary place in the world community… The rise and fall of national power is perhaps the most obvious theme of history. In the interest of world freedom, being ‘number one,’ poses to the U.S. the responsibility of remaining ‘number one.’ … In this regard, each of us has a responsibility for improving technical education in the United
States. This responsibility has grown with the advent of the so-called Space Age."69 This idea had obvious cachet in the early 1960s.

In fact, U.S. identity itself seemed to logically be intertwined with its technological prowess. As Killian noted, “There is the diplomatic opportunity to grasp a powerful new lever to advance our national interest in the world arena. The United States has exceptional technical resources that are understood all over the world, both by advanced peoples and by less-advanced peoples. This scientific and technological strength is among the most conspicuous, most admired, and most persuasive features on the American landscape—more so, to other peoples, than even our cherished democratic system which has made our flourishing technology possible.”70

The moment for this ideology was fleeting, however. By the late 1960s the technological positivism of the United States became wracked by the Sisyphean quagmire of the Vietnam War; by the social and urban crises at home, which threw the inability of the country to solve its own problems, technologically or otherwise, into stark relief; by a rising environmental movement opposed to society’s profligate fixation on establishment-commanded high technologies; by a fracturing political arena increasingly turning to neoliberalism on the right and neocolonial and anti-development critiques on the left; and by diplomatic, economic, and ideological pushback from allies and developing countries alike. Meanwhile, much as in the case of Point Four a decade prior, the practical difficulties of the country’s development programs outran the grandiose rhetoric being

69 Johnson, “Higher Education and Advanced Research.”
70 Address, J.W. Joyce, “The Role of Science in Foreign Affairs,” Augustus Gardner Post No. 18, American Legion, April 23, 1965, RG59, Bureau of Scientific and Technological Affairs, Central Files, entry 3008D, box 37, NARA.
espoused by the leaders promoting them, and came into tension with both Americans’ wavering commitments and the imperialism and covert political violence they waged across the Global South. Simply put, technological globalism failed to bend the world to the U.S.’s interests in the way that its promoters had always hoped and claimed.

The ideology’s brief window of primacy, however, is understandable when considering the genealogy of ideas that had been incubated since the Second World War. Future-oriented technological globalism was noteworthy for its totality: It seemed to explain the entire world as something legible and controllable in a holistic way that had not been available or plausible in previous eras of history. Technology now fed a total worldview in the way that communism once had. Unlike communism, however, the key to technological globalism’s attractiveness was that it was evolutionary rather than revolutionary. Unlike technocracy or the totalitarian ideologies of the twentieth century, it promised not to be disruptive, except in ways salutary to the United States. It took existing social conditions and worked to improve them in ways that would not fundamentally change the existing social or geopolitical order. It would advance the human condition, but not in ways that were too radical or beyond the reach of the sponsoring state. That was why Sputnik was so terrifying—it temporarily challenged that comforting vision. It was why the United States responded to the satellite by funneling untold billions of dollars into new technoscientific initiatives. And it was why the ideology collapsed so dramatically once it became apparent that better living through science was not as easy or controllable as promised.
The unraveling was quick and devastating, coming as it did on two fronts. On one hand, precisely the marriage of technical expertise and power politics meant that technoscience came to be inextricably associated with the increasingly reviled Establishment. On the other hand, when the state’s hubristic attempts to actually apply the ideology of technological globalism in America and in the world revealed themselves to be more destructive than constructive, faith in R&D solutions to global problems suffered similar reputational harm to the midcentury faith in expertise itself.

Yet, the legacy of the Tizard Generation and its ideology remains. Studies linking industry, technology, science, and “national systems of innovation” to economic strength, GDP, and international competitiveness did begin to percolate into states’ policymaking activities. Governments did continue to build bigger, more powerful, and more strategic technologies, laboratories, and arms. Anxieties about brain drains, “know-how,” intellectual property, and technology transfer continued to roil between both industrial and industrializing economies. Technology-fed globalization changed the international calculus of trade. And new sectors—from biomedicine to microelectronics to the internet economy—repeatedly disrupted the industrial status quo and reoriented international relations. In the United States, agencies like the NSF, ONR, and National Institutes of Health continue today to spend billions of dollars annually on research and development, every year adding new knowledge and new innovations to the postmodern material world built by the American state during and after the Second World War. And organizations like them across the world—sometimes collaboratively, sometimes in competition—do the same.
In sum, the curious trajectory of the American government in eschewing and then coming to embrace a centralized command of science and technology, provides an important historical case study demonstrating the conceptual divide between hegemony on one side, and states’ technological prowess on the other. Once we grasp the fact that hegemonic technology does not automatically coincide with industrial capacity or economic might, we can treat it as a separate historical variable. And when we do so, we find the beginnings of a key marker of U.S. power projection in the mid-twentieth century, and, indeed, begin to better understand its unraveling.

In so many ways by the 1940s, the United States was ready to be—and, indeed, was acting as—a world power, but it nevertheless remained fundamentally unprepared to join the paradigm of diplomatic, bureaucratic, and centralized technological hegemony practiced by other powerful states. But as British scientists switched on their radar equipment on a September day in 1940, one need only imagine the looks on the faces of astonished American officials to remember that what states conceive of as central to global power is an ever-changing thing.
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