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ABSTRACT

Title of Dissertation: PLANNING FOR MODERN WAR: RAND AND THE AIR FORCE, 1945-1950

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This study details the context and motivations that brought a new organization, Project RAND and later the RAND Corporation, into being after World War II under the auspices of the Army Air Forces. RAND's founding was shaped by a specific challenge of the immediate postwar years. The new weapons of war--long-distance aircraft, guided missiles, radar, atomic bombs--stimulated a widely-shared perception on the need for continual military preparedness. These weapons, too, were largely the product of private industry and universities. To prepare for modern war many military, industrial, and academic leaders actively sought specific mechanisms to connect the military with civilian sources of research and development. Declining military appropriations in the years before the Korean War emphasized the urgency of this task.

RAND and the Air Force pursued a distinctive approach to this challenge, attempting through their relationship to reform service management of research and development and to establish a conduit from Air Force leadership to the aircraft industry and universities. RAND embodied, at different stages, two strategies for coordinating scientific and technical resources in support of serv-

ice interests. One was administrative, seeking to link Air Force management with the top leadership of the aircraft industry through a voluntary trade association, reminiscent of Herbert Hoover's efforts to control markets in the 1920s. The other strategy was to draw on the authority of science and make air warfare--its technology, institutions, and place in national life--a new field of inquiry, essential to preparing for modern war. These strategies, it is argued, were tailored responses to the pluralistic character of U.S. policy making and politics. The production and use of the new weapons seemed to call for integration and coordination among American institutions, yet political traditions from the prewar and war time offered relatively ineffective tools to achieve these ends.

PLANNING FOR MODERN WAR: RAND AND THE AIR FORCE,

1945-1950

by

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Introduction

Thesis

In November 1947, just eighteen months after an Air Force contract established Project RAND at Douglas Aircraft, a RAND writer tried to capture the animating spirit of the new enterprise. He sought to illuminate a postwar landscape in which relations among science, technology, and the military were still being defined:

> [this progress report] will emphasize the problems encountered, the progress made, and the tasks to be accomplished. It cannot relate the intangible benefits of the project--the intensive thinking of more and more civilians on military problems, the spread of a feeling of personal responsibility for national security among industrialists as well as scientists and technologists. The test of these gains can come only in the future. Still, if modern weapons have wiped out the sharp distinction between the military and civilian in time of war, so in time of peace such a differentiation has become outdated. RAND is in line with this development and thus by its very existence aids the nation to face the dangers ahead.[1]

This statement framed a series of widely-discussed questions in the period: how had modern weapons and war redefined the relation between the civilian and the military; between those who researched, developed, and built such weapons and those who purchased and used them; and between possessors of scientific knowledge and technical skill in universities and industry and those with a direct responsibility for national security. The experiences of World War II and the prospect of future wars global in scope gave these questions special urgency? Long-range bombers, atomic weapons, and campaigns of strategic bombing seemed all

1. Draft, "Sixth Quarterly Report," 1947, Folder "War Effort--RAND Letters, 1944-03/48," Box 1, E. L. Bowles Papers, NASM.

too solid proof of the idea that modern war, more than in previous periods, was a contest between whole societies, not just between opposing military forces. For many political and military leaders, academics, and industrialists, questions linking new weapons, scientific and technical knowledge, and their respective institutions were of the first importance.

New institutions were already starting to give form to these relations. In 1946, the Office of Naval Research (ONR) had been established to attract university scientists to the work of the Navy; and, in September 1947, the Research and Development Board (RDB) had been created to oversee the research activities of the military services in the new National Military Establishment.[2] RAND distinguished itself from other postwar efforts by linking two crucial actors: the aircraft industry and the Army Air Forces.

This dissertation focuses on Project RAND, later the RAND Corporation, and its founding and development in the early postwar period. Project RAND was created through an Army Air Forces contract with Douglas Aircraft Company in March 1946. The RAND Corporation followed in 1948 as the project established itself as a nonprofit corporation. RAND, of course, was not the only site at which these questions were formulated and at which answers were negotiated. The debate over a National Research Foundation (NRF) and the formation of the ONR

2. On the ONR see Harvey M. Sapolsky, *Science and the Navy: The History of the Office of Naval Research* (Princeton: Princeton University Press, 1990); on the RDB see Steven L. Rearden, *History of the Office of the Secretary of Defense, Volume I: The Formative Years, 1947-1950* (Washington, D.C.: Historical Office, Office of the Secretary of Defense, 1984).

and RDB were part of the same postwar landscape in which RAND took shape. They, too, fashioned responses by combining familiar elements like personal commitment, attitude, and ideology into new institutions for mediating between the civilian and military spheres.[3]

RAND, though, grew within a unique context. In its first years RAND was defined by the interests of its principals: a major aircraft firm and the leadership of the Army Air Forces. In the foreground at RAND were the concerns of industry, the Air Force, and weapons-directed research, rather than the interests of science, academia, and government sponsors as in the cases of the NRF and the ONR. Even with RAND's establishment as a separate nonprofit entity in 1948, these concerns still informed the ways in which RAND approached the problems of weapons, scientific and technical knowledge, the military, and political economy.

3. On the extent of postwar planning during and at the end of World War II see Michael S. Sherry, *Preparing for the Next War: American Plans for Postwar Defense, 1941--1945* (New Haven: Yale University Press, 1977). On science and the state during this period see A. Hunter Dupree, "The Great Instauration of 1940: The Organization of Scientific Research for War," in G. Holton, ed., *The Twentieth Century Sciences: Studies in the Biography of Ideas* (New York: Norton, 1972):443-467; J. Merton England, "Dr. Bush Writes A Report": *Science: the Endless Frontier*," *Science 191* (1976):41-47; Daniel J. 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* (1975):20-47; Kevles,"The National Science Foundation and the Debate Over Postwar Research Policy," *Isis 68* (1977):5-26; Kevles, *The Physicists: The History of a Scientific Community in America* (New York: Knopf, 1977); Nathan Reingold, "Vannevar Bush's New Deal for Research: Or the Triumph of the Old Order," *Historical Studies in the Physical and Biological Sciences 17* (1987):299-344; J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945-1957* (Washington, D.C.: NSF, 1982); and Sapolsky, *Science*, note 2.

This dissertation makes two interrelated claims. One already has been implied: RAND was part of an active and purposeful exploration of ways to remake the relations among American institutions concerned with science, technology, and the military. This problem motivated those most closely involved with RAND: Arthur Raymond and Frank Collbohm of Douglas Aircraft and Commanding General of the Army Air Forces Henry "Hap" H. Arnold and his Special Consultant Edward L. Bowles. Previous historical accounts of RAND have viewed it as an unsurprising extension of wartime relations between experts and the military services, and have overlooked the motivations behind the project's founding and early development.[4]

The second claim concerns the strategies devised by the principal actors to refashion social and knowledge relations. Two factors defined possible strategies: the intellectual and administrative tools the actors had at their disposal and the limits imposed on their efforts by American political traditions. The first strategy, implemented from 1946-1948, was predominantly administrative. Social and

4. See Bruce Smith, *The RAND Corporation* (Cambridge, MA: Harvard University Press, 1965); Fred Kaplan, *Wizards of Armageddon* (New York: Simon and Schuster, 1983); and Gregg Herken, *Counsels of War* (New York: Alfred A. Knopf, 1985). Two recent accounts provide a richer overview of RAND's activities but fail to place them in the context of Air Force organizational changes and problems. See David Hounshell, "The Cold War, RAND, and the Generation of Knowledge, 1946-1962," *Historical Studies in the Physical and Biological Sciences* 27 (1997):237-267; and David R. Jardini, "Out of the Wild Blue Yonder: The RAND Corporation's Diversification into Social Welfare Research, 1946-1968" (Ph.D. diss., Carnegie Mellon University, 1996). Accounts of RAND's history may also be found in several personal memoirs; see for example, Philip Morse, *In at the Beginnings: A Physicist's Life* (Cambridge, MA: MIT Press, 1977).

knowledge relations among industry, scientists, and service leaders would be remade through a voluntary trade association of aircraft companies under the RAND contract with the Air Force. It was a strategy reminiscent of the trade association models promoted by Herbert Hoover in the 1920s.[5] The second strategy, prevailing from about 1948 through 1950, was to make the Air Force--its operation, its organization, its present and future weapons, even its place in American society--the subject of a new research domain, a distinct category of scientific inquiry. Research in this context would provide a means for understanding this domain and its relation to traditional disciplines, as well as provide practices, a language, and results for defining social relations within and external to the Air Force. Both strategies were, in part, a response to the decentralized and pluralistic character of decision-making in the military and in national political forums. The production and use of modern weapons seemed to call for integration and coordination among American institutions, yet political tradition offered relatively ineffective tools to achieve these ends. RAND offered a place to experiment with old and novel strategies for addressing this challenge of the postwar period.

The administrative and knowledge strategies developed at RAND were distinctive of the period from the end of World War II to the start of the Korean War. This concern with planning and coordination derived in part from the widely-shared sense that the military and nation needed purposefully to sustain the

5. On Hoover and his approach to defining relations between the market and the state see Ellis Hawley, "Herbert Hoover, the Commerce Secretariat, and the Vision of an Associative State, 1921-1928," *Journal of American History* 61 (1974):116-40.

cooperative arrangements of the war years and to prepare actively for the possibility of future war. It also was a result of the sharp trend downward in military budgets from wartime highs. In the case of the Air Force, these circumstances stimulated experimentation with new approaches for coordinating relations with industry, academia, and other elements of government.

By the beginning of the Korean War, the perception that special action was required to achieve coordination on a broad scale diminished substantially. After World War II the military, industry, and academia forged extensive working relationships through contracts and the activities of these new organizations--though such interactions were frequently disjointed and resistant to coordination and often rife with interservice rivalries and unwieldy processes of decision-making in the National Military Establishment. Equally, if not more important, was the substantially increased military funding unleashed by the start of war in June 1950. Military budgets shot upward as did the flow of contract money to industry and universities. The increased expenditures made the pre-conflict efforts to coordinate planning, such as those at RAND, seem less necessary.[6]

6. On the increased flow of military expenditures see Paul Forman, "Behind Quantum Electronics: National Security as a Basis for Physical Research in the United States, 1940-1960," *Historical Studies in the Physical Sciences* 18 (1987):149-229. On the institutional differences before and after the start of the Korean War see Daniel Kevles, "Cold War and Hot Physics: Science, Security, and the American State, 1945-56," *Historical Studies in the Physical and Biological Sciences* 20 (1990):239-264; and Allan Needell, "Preparing for the Space Age: University-based Research, 1946-1957," *Historical Studies in the Physical and Biological Sciences* 18 (1987):89-110. Daniel Yergin also argues that the Korean War was the final piece in the establishment of what he calls the national security state; see Daniel Yergin, *Shattered Peace: The Origins of the Cold War and the National Security State* (Boston: Houghton Mifflin Co., 1977):395-412.

This dissertation focuses on these several years when there was a shared sense among leaders, in and outside the military, that modern war might require specific but limited state interventions to coordinate relations among the military, industry, and academia. RAND was part of a new and widely-considered question of the postwar period: How could the institutional pluralism and anti-statist strains of the American political landscape be reconciled with the military interest in new weapons? The first tended toward the distribution of power and resources, the latter toward a strong concentration of power and resources in the military. Strategies of nationalization or rigid central control were not possible. Other approaches that balanced pluralism against statist control had to be crafted.[7] Still to be understood is how the problem of weapons provided the opportunity for reworking the balance between pluralism and centralization and for reconstituting the relations among science, technology, and the military. Drawing on primary

7. Possible models for intervention were derived from Progressive era and New Deal political culture. One was active involvement of the state in managing and regulating capitalist institutions. Another complementary state planning strategy was Keynesian fiscal policy. This policy substituted fiscal funding and incentives for explicit institutional devices in controlling the private sector. Private sector behavior was organized through monetary opportunities and incentives. For a penetrating examination of these New Deal planning strategies and the eventual triumph of fiscal strategies of control after World War II see Alan Brinkley, "The New Deal and the Idea of the State," in *The Rise and Fall of the New Deal Order* (Princeton, NJ: Princeton University Press, 1989): 85-121. Analyzing the postwar military through its use of interventionist and fiscal regulating strategies is a promising line of interpretive attack. One analysis of the effectiveness of a fiscal regulating strategy, although the author does not connect his study to this New Deal tradition, is Paul Forman, "Behind Quantum Electronics," note 6. On the strength of anti-statist strains in management of the postwar military see Aaron Friedberg, "Why Didn't the United States Become a Garrison State?," *International Security 16* (1992):109-43.

documentation from the Air Force and RAND, this study places RAND in the context of these questions of the immediate postwar years.

Underlying these claims is also an argument on understanding the creation of the "national security state," as Daniel Yergin named the interconnecting set of ideas, interests, and private and government institutions associated with the Cold War.[8] Literature in diplomatic and political history argues that this development was largely a consequence of a process of high-level policy-making centered on the President, State Department, Joint Chiefs of Staff, and the National Security Council.[9] Recent work in the history and social studies of science and technology makes a different argument: The creation of a national security state was perhaps more the result of building many individual working relationships. In this literature the focus has been on the varied working relationships between military services and university laboratories. Perhaps, this argument goes, the national security state was created from many local relationships rather than as a product of an over-

8. Yergin defined this phrase as as how the U.S "had to become organized for perpetual confrontation and for war. The unified pattern of attitudes, policies, and institutions by which this task was effected comprise what I call America's 'national security state.' It became, in fact, a 'state within a state'." Daniel Yergin, *A Shattered Peace*, note 6, p. 5.

9. Of course, this literature is very diverse on how this process operated and who influenced it--for example, whether the motive force was a realistic appraisal and response to the Soviet threat by U.S. leaders or an effort by government and business elites to secure international markets for American industry. Despite these differences the focus of research in much of this literature has been on the process of high-level national policy-making. A useful overview of explanatory approaches in the field is Michael Hogan, ed., *America in the World: The Historiography of American Foreign Relations Since 1941* (Cambridge, Eng.: Cambridge University Press, 1995).

arching process of policy-making.[10] It was in such local venues that important relations among research, weapons development, and politics were defined.

This dissertation draws on this latter argument. In the RAND case, though, the focus is on actors who operated apart from the laboratory and, for the most part, from circles of high policy. The RAND principals and their associates on the Air Staff represent another group of individuals active in defining relations among the service, industry, and academia: a middle and upper management drawn from the service and industry.

In elaborating these claims, this narrative will cover RAND's development and its relation to the Air Force, from its postwar founding through 1950. RAND was conceived as an adjunct to the Air Staff, the part of the Air Force responsible for management and decision-making. For most of this period RAND was a managerial and knowledge resource, a place to assemble and apply scientific and technical know-how around Air Force problems of intercontinental warfare. But the ways in which these roles intersected with service interests changed over time. In 1946 RAND was a fledgling institution. The organization had a staff of less than one hundred, composed primarily of engineers from the aircraft industry and a few mathematicians. By 1950 RAND had begun to look quite different. Profes-

10. The clearest expression of this argument is in Michael Dennis, "Our First Line of Defense: Two University Laboratories in the Postwar American State," *Isis* 85 (1994):427-455.

sional staff now totaled several hundred, with diverse disciplines represented.[11] Economics, political science, and sociology, as well as a spectrum of science and engineering disciplines, had places in the institution. The link between the early and later RAND was the challenge of planning for intercontinental warfare. RAND, the Air Force, and the question of planning for future war were defined and redefined in the years after World War II.

Literature Review

In outline, the RAND story seems familiar. It may be viewed as another institutional lens through which to focus on the relations among science, technology, and sources of social support. This narrative line has been an important one in recent historiography. It has provided a strategic means for opening up the notion of science as an autonomous activity, asking how scientific knowledge was derived and then legitimated outside the laboratory. Indeed, this literature has helped reveal the ways in which the very categories of science and society have been constituted and established.

In historiography on the twentieth century, a periodization based on sources of support might be constructed. In the first decades of the century, the philanthropy of foundations and the gifts, contracts, and consulting positions of industry were dominant. During and after World War II, military money defined the landscape of support. In each case, studies have helped us see how support and

11. For such data, see, for example, the report of operations in "Eleventh Semi-Annual Meeting of the Board of Trustees, Agenda Material," November 1959, RAND Archives.

the motivations associated with it have interacted with the practice of science and technology--how research domains were defined and problems selected, for example, and how, in turn, knowledge and professionals were instrumental in forging and securing particular social relations.[12]

Studying the relations among society, science, and technology is at the heart of this dissertation, too. But the focus here shifts to other strategic sites in the shaping of science and society in the postwar period. Recent literature, for the most part, directs our attention to the laboratory and the university and their connections with military offices directly concerned with funding science and technology. The focus has been on the ways in which a flood of military support altered disciplines, academia, and the meaning of the civilian.[13] Critical to this account

12. On the structure of prewar support see Roger L. Geiger, *To Advance Knowledge* (New York: Oxford University Press, 1986); Robert Kohler, *Partners in Science: Foundations and Natural Scientists, 1900-1945* (Chicago: University of Chicago Press, 1991); and Larry Owens, "MIT and the Federal 'Angel': Academic R&D and Federal-Private Cooperation before World War II," *Isis* 81 (1990):189-213; for an overview of the military role in postwar support see Paul Forman, "Behind Quantum Electronics," note 6.

13. Most of the research has come from the history of science, with emphasis on the relation of the physical sciences with the military. Typically, however, authors do not attempt to distinguish what counts as science from what counts as technology. An introduction to the literature can be gained through several collections of essays, including E. Mendelsohn, M. Roe Smith, and P. Weingart, eds., *Science, Technology, and the Military* (Boston: Kluwer Academic, 1988); P. Galison and B. Hevly, eds., *Big Science: The Growth of Large-Scale Research* (Palo Alto: Stanford University Press, 1991); and M. Roe Smith, ed., *Technological Change and Military Enterprise: Perspectives on the American Experience* (Cambridge, MA: The MIT Press, 1985). Important also are Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960," note 6; and the recent work by Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (New York: Columbia University Press, 1993). Recent dissertation work has also added to this literature. See for example, Rebecca S. Lowen, "Transforming the University: Administrators, Physicists, and Industrial and Federal Patronage at

will be a different set of actors less visible in previous studies: the aircraft industry and the top management cadre of the Air Force. Although RAND drew upon university-based disciplines and practitioners, it developed and organized its disciplinary resources in the context of and in response to its connection to industry and to Air Force management. As such, a different light is shed on how we perceive the development and constitution of a new political economy centered on war and preparedness.

In building this political economy, one connective thread ran through weapons research and development, university laboratories, and military program offices. But the RAND case presents another: The Air Force had to refashion itself as a corporate entity to reflect the new reality of warfare: the possibility of national destruction across great distances and with little warning through the use of long-distance aircraft, atomic bombs, and the potential of ballistic missiles. The urgency, scale, and complexity of responding to such a possibility placed science and technology at the center of the Air Force's institutional life. How to organize for weapons research, development, and production was a key question. Such concerns underlay RAND's charge to research the subject of intercontinental warfare.

Stanford, 1935-1949," *History of Education Quarterly* 31 (1991):365-88, and Michael A. Dennis, "A Change of State: The Political Cultures of Technical Practice at the MIT Instrumentation Laboratory and the Johns Hopkins University Applied Physics Laboratory, 1930-1945" (Ph.D. diss., Johns Hopkins, 1990). The history of technology has provided some useful models for analyzing research directed toward specific institutional goals in Leonard S. Reich, *The Making of American Industrial Research: Science and Business at GE and Bell, 1876-1926* (New York: Cambridge University Press, 1985), and George Wise, *Willis R. Whitney, GE, and the Origins of American Industrial Research* (New York: Columbia University Press, 1985).

This was not just an issue of establishing offices and programs which could draw on university resources. It struck to the core of traditional service institutional ideology and practices. It meant both refashioning the service itself and its relations with industry and universities. This process had special importance through the late 1940s. The individual military services had the means and authority to remake themselves and their external relations with industry and universities.[14] The Air Staff was thus a distinctive and instrumental site for building a key part of the postwar political economy.

RAND was one part of this institutional refashioning--inseparable, it will be argued, from the interests, motivations, opportunities, and constraints confronting the postwar Air Staff. Embedded in this story are lines of conflict described in studies on the university and the military. Questions of institutional autonomy and of the integrity of professional standards of knowledge production in an environment defined by military financial support and interests were as pervasive at RAND as they were in academia. However, different aspects of these themes are thrown into relief when placed in the context of Air Force managerial concerns rather than that of the university and the laboratory.

This dissertation will engage these questions and themes by drawing on two literatures. One includes studies of American history falling generally under the

14. On the autonomy of the individual services in key areas of decision-making see Rearden, *History of the Office of the Secretary of Defense*, note 2, chapter 1.

rubrics of corporate liberalism and the organizational synthesis.[15] The core focus of this literature has been the rise of a corporate capitalism in the late nineteenth century and the political and economic responses in the profound shift from a nation characterized by numerous, small proprietary businesses to one featuring large concerns wielding unprecedented market power. This literature has relevance in several ways. Within the American context, science and technology both enabled the new corporate forms through knowledge and inventions and provided professional resources for managing these new organizations as well as for the regulatory institutions that would develop to control them. Engineers especially in the late nineteenth century and early twentieth century saw themselves broadly as mediators among the worlds of science, business, and government.[16] As the problem of working out the interactions among the corporation, the marketplace, and politics was elaborated over these several decades, a range of both governmental and private institutional structures and strategies was tested. These efforts provided a repertoire of political and institutional tools for working out relationships between government and the private sector, defining different balances between

15. The most complete overview of this literature and its relation to the history of science and technology is Brian Balogh, "Reorganizing the Organizational Synthesis: Federal-Professional Relations in Modern America," *Studies in American Political Development* 5 (1991): 119-172. See also Louis Galambos, "The Emerging Organizational Synthesis in Modern American History," *Business History Review 44* (1970):279-90, and "Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis," *Business History Review 57* (1983):471-93, as well as Ellis W. Hawley, "The Discovery and Study of a Corporate Liberalism," *Business History Review 52* (1978):308-20.

16. The most detailed examination of this point is John M. Jordan, *Machine-Age Ideology: Social Engineering and American Liberalism, 1911-1939* (Chapel Hill: The University of North Carolina Press, 1994).

state and private control, and between centralization and decentralization--all for the purpose of controlling or coordinating the market to counteract the perceived deleterious effects of corporate capitalism. It is one argument of this dissertation that these understandings on defining possible roles of governments and markets were a crucial backdrop for crafting the postwar relationships among the military, industry, and academia.

RAND and the Air Force addressed problems comparable to those confronted by government planners and professional elites in the early twentieth century. At issue were the relations among a government entity and producers external to it--aircraft firms and selected universities. The problem was to control and coordinate these producers to research, develop, and manufacture weapons. That earlier conceptual tools and institutional models should be applied in the postwar period is not too surprising. Many of the leading shapers of the postwar period had experience in prewar institutions, including individuals central to this account: Commanding General of the Army Air Forces Henry "Hap" Arnold, Edward L. Bowles, an MIT professor and consultant to Arnold, and members of the RAND leadership such as Arthur Raymond, Frank Collbohm, and Richard Goldstein, all of whom had been with Douglas Aircraft since the early 1930s.

The second literature to be drawn on here includes studies from the history of science and technology, especially those concerned with the intersection of knowledge production and politics.[17] A second argument of this dissertation is that, in

17. See note 13.

the RAND case, knowledge came to serve a specific role: as an instrument for controlling and coordinating the complex relations among the Air Force, academia, and industry. It did so in a very novel way. Through RAND, the Air Force itself and its activities became subjects of study--its organizing principles; its institutional practices; its relationship to science and technology in the research, development, and production of weapons; and its concepts of warfare, defense, and strategy. This conceptual turn was rooted in several specific problems confronting the Air Force in the late 1940s: selecting a new long-range bomber, planning for air defense of the United States, and evaluating the possibilities of intercontinental missiles. All of these would be undertakings of broad importance, embracing questions of strategy and total war and of the mobilization of service and national resources on a large scale.

These problems highlighted how technical choices seemingly were inseparable from questions of politics and the service's organization and decision-making processes. They seemed to constitute a distinct domain of phenomena. RAND called this new research domain and the methodology for its study "systems analysis"--the use of mathematics and other disciplinary expertise to define and study such large-scale problems. Systems analysis sought to model a broad range of technical and political variables associated with conducting modern war. In part, systems analysis grew out of the wartime practices of operations research. It came to be promoted as the corporation's signature product. This invention offered the promise of charting an analytic path through the Air Force's--and the nation's--difficult options in the postwar world. Equally, though, systems analysis was a tool for defining relations among and coordinating the many institutional sites, internal and external to the Air Force, with stakes in service activities.

The Air Force as subject constituted a research domain that was inherently political. Air Force interests were implicitly and explicitly objects of study. Such interests served to redefine the domain as political circumstances changed and to provide criteria for selecting problems and organizing intellectual resources in the RAND research effort. Research conclusions generated in this context embodied certain assumptions about the relations between politics and knowledge and about the relations among institutions.

A central theme of the RAND story is the attempt to create and elaborate systems analysis as a methodology for studying the Air Force as research domain. It was articulated in the context of specific issues of the late 1940s and early 1950s: the evaluations of long-range bombers, air defense, and guided missiles. Systems analysis was built on the practices and intellectual resources of science, technology, and the social sciences. This invested the methodology with the legitimacy of established scientific practice, enhancing the acceptance of the research effort within RAND, the Air Force, and other decision-making forums. The possibility of gaining agreement in different forums through such research was one means of addressing the problem of controlling and coordinating the work of the Air Force and its relations with industry and academia.

This argument of the dissertation builds on insights of the social studies of science literature.[18] Some of this literature argues that establishing knowledge claims in science has a critical rhetorical component. Moving knowledge from the laboratory to external forums is not a process of dispassionate organized skepticism as argued by sociologist Robert Merton, but is rather one of active conflict and persuasion.[19] Knowledge claims--facts, theories, and methods--must be stabilized by anchoring such claims in previous research and adopting styles of presentation that minimize opportunities for questioning results. Much is at stake in this process. Implicit in new facts, theories, and methods are assumptions on conceptual categories appropriate to a research domain. They stand as a possible challenge to established categories that serve to organize political and institutional interests. Scientists, in this interpretive scheme, define and organize nature as well as politics and society.

18. This literature is now extensive. A useful overview of writing on the interaction between politics and knowledge in science is Sergio Sismondo, "Some Social Constructions," *Social Studies of Science* 23 (1993):515-553. One of most influential voices in this regard is Bruno Latour. See Bruno Latour, *Science in Action* (Cambridge: Harvard University Press, 1987). Latour's paradigm example of the laboratory's role in defining nature and politics is Louis Pasteur's discovery of bacteria and his subsequent efforts to recast the conceptual basis and institutions of public health in France: Bruno Latour, *The Pasteurization of France* (Cambridge, MA: Harvard University Press, 1988). For an insightful critique of Latour's perspectives and of his Pasteur study see Simon Schaffer, "The Eighteenth Brumaire of Bruno Latour," *Studies in History and Philosophy of Science* 22 (1991):174-192.

19. Merton's views--which claim that the practice of science is substantially independent of society--stand as a counterpoint to contemporary social studies of science, which, like Latour, argues science is inextricable from its social context. For the latter literature, the challenge is to identify the particular ways this interdependence affects science and society. Merton's classic presentation of his position is: Robert K. Merton, "Science and Technology in a Democratic Order," *Journal of Legal and Political Sociology* 1 (1942):115-126. Merton argued that the norms of universalism, communism, disinterestedness, and organized skepticism enabled science to establish itself as a self-regulating, independent activity.

This insight on the interconnection of science and politics has useful application in the RAND-Air Force case. The Air Force as research domain was a setting in which politics, institutional roles, and the distribution of resources were patently part of the objects of study. Research in this domain could not fail to have political implications. The results of such research would imply particular ways of ordering the political and institutional life of the Air Force, as well as that of universities and industry. The ability of such claims to persuade rested both in the use of scientific and technical methodology and in the fact that the objects of study were frequently individual technologies or aggregations of technologies. The strategy was to make the study of weapons comparable to the well-grounded traditions of scientific study of nature.

Both in methodology and in the subjects chosen for study, systems analysis promised, in the eyes of RAND staff and some of their Air Force counterparts, a possibility of objectivity, of distinguishing between the scientific and the political. Making systems analysis a scientific discourse conferred a rhetorical benefit: as with science, its claims could be regarded as objective and decoupled from politics. Systems analysis as a kind of scientific discipline was also pragmatically linked to the idea that scientific advance was central to military preparedness in postwar period. RAND leadership and their Air Force counterparts believed strongly in science as an autonomous force and in continuous innovation. Such ideology and research practices defining the Air Force as a scientific domain of study were mutually reinforcing. They helped to mark off the boundary between knowledge and politics. This connection between research and ideology was an important part of RAND's institutional identity, establishing it as a research site, not a political appendage. Nonetheless political and institutional choices were linked to claims about weapons and weapons systems contained in RAND's systems analyses. To the degree that such claims could be made persuasive beyond RAND and the Air Staff offices closest to it, they helped to control and coordinate a diverse range of institutional actors.

The two literatures referred to above illuminate specific aspects of RAND's history. Studies on corporate liberalism and the organizational synthesis situate the RAND-Air Force relationship within a decades long response to the general problem posed in the rise of corporate capitalism--the intersection of science and technology with government and the marketplace. These experiences provided specific opportunities and constraints in the postwar definition of the relations among the military, industry, and universities. Moreover, situating RAND and the Air Force in this literature provides an important corrective to a shortcoming of the history of science and technology literature: a focus on the relations between university science and the military after World War II with less attention to the role of industry and to interests of military leadership in securing relations with all sources of science and technology. The problem of intercontinental warfare for the Air Force hinged on organizing a broader political economy, of which academia was but one part. Equally germane were industry and the Air Force's internal organization and processes. Each of these sites interacted with and influenced the development of the other. The earlier problem of the corporation reminds us that

RAND and other postwar institutional inventions were part of a history of organizational experimentation for defining relations among the state, the market and academia.

The history of science and technology, though, can address a lacuna in the literature of corporate liberalism and the organizational synthesis. In the latter literature, science, technology, and professions are treated as external variables. They represent occasional but important drivers of change, yet the mechanisms by which this occurs and relates to politics are left unexamined. The focus of analysis is on the actions of the state and the market *after* technologies and knowledge have become institutionalized. The history of science and technology literature offers specific strategies for understanding how science, technology, and professions help to recast politics, the market, and institutions. It helps to connect the local work of research sites, where knowledge production occurs, with the larger frames of reference associated with analyses of the state and the market. In so doing, history of science and technology literature offers a more nuanced account of causality. Science and technology are not simplistic drivers of social change, rather they may be considered as opportunistic sites in which scientific, technical, and political actors may choose among options that may satisfy different scientific, technical, or political ends. Relations among science, technology, the state, and the market are built up together and interdependent.

These two literatures, then, provide a framework for understanding RAND and the strategies it created to mediate problems between the Air Force and external resources. This interpretive perspective is important. RAND's own corporate image is a montage, a composition of discrete accomplishments: its pioneering studies on space satellites, its assessment of the strategic implications of the H-bomb, Albert Wohlstetter's strategic base study, recommendations that led to an accelerated ballistic missile program, and numerous others firsts and successes. The existing literature on RAND's history is also selective. The very useful histories on nuclear strategy fail to explore the institutional context within which this work developed. Bruce Smith's important institutional study of RAND, published in 1965, is organized around a question pervasive in the 1960s: who should make government policy? This is of interest to political science, but fails to address the questions and issues with which RAND and the Air Force grappled in the 1940s and 1950s or the manner in which these changed over time.[20]

This dissertation makes a different argument, situated precisely in the problems that the Air Force and its civilian associates confronted at the conclusion of World War II and afterward. RAND was an embodiment of both administrative and knowledge strategies designed to remake the Air Force to fit the new assumptions of warfare: advanced armament at the ready and social organization prepared to achieve this result. It was both representative and distinctive of the paths available for constituting a political economy centered on war preparedness and weapons, demonstrating the opportunities, constraints, experimentation, and confusion that were part of the postwar period. It drew on the repertoire of state-market

20. For examples of RAND's self image see *The RAND Corporation: The First Fifteen Years* (Santa Monica: The RAND Corporation, 1963) and *The RAND Corporation: 40th Year* (Santa Monica: The RAND Corporation, 1989). See note 4 on RAND in the nuclear strategy literature and for Smith, *The RAND Corporation*.

strategies developed before the war, as well as two new tools available to the military: the contract and security classification to control information. Integral to this process was RAND's organization and use of its disciplinary resources. RAND developed systems analysis, a set of knowledge practices aimed at providing new conceptual bases for controlling and coordinating the diverse institutional sites that formed the Air Force enterprise.

Structure

This dissertation will not be a history of the various disciplines at RAND. Rather it will focus on the group of individuals at RAND and within the Air Force who directly shaped the interaction between the service's interests and RAND's knowledge practices. Within RAND, this group included selected members of the Board of Trustees, such as lawyer Rowan Gaither and California Institute of Technology president Lee Dubridge; RAND's top management including Frank Collbohm, Richard Goldstein, and Lawrence Henderson; RAND department heads such as mathematician John Williams, engineer Edward Barlow, and economists Charles Hitch and David Novick; and a few researchers such as mathematician Edwin Paxson. Together these individuals defined RAND research practices in concert with a changing guard of Air Force officials. Initially, General Arnold and General Curtis LeMay, the Deputy Chief of Staff for Research and Development from 1946 to 1948, were the leading figures. By 1950 day-to-day Air Force interaction with RAND was situated within the newly created Deputy Chief of Staff for Development office, the unit responsible for planning and coordinating service research and development. It was in this nexus between research and management that RAND leaders and their Air Force counterparts sought to work through the central problem of the postwar Air Force: the research, development, production, and use of science- and technology-based weapons, requiring the specialized resources of universities and industry.

Chapter I explores the wartime background of Hap Arnold and Edward Bowles and their distinctive approaches to postwar planning. Chapter II examines how they applied their ideas and wartime experience to reform the Army Air Forces organization of research and development, concentrating control over these activities in the Air Staff. It also details the first steps to establish RAND as another element of their reform effort. Chapter III relates Bowles's ultimately failed attempt to extend further his and Arnold's reforms by establishing a cooperative planning arrangement between the Air Staff and the aircraft industry through RAND. Chapter IV examines, in the wake of Bowles's failure, how the idea of making air warfare a science emerged and then defined RAND as an organization. Finally, Chapter V looks at the articulation of RAND's first systems analysis; how it became intertwined with major policy issues of 1948-1950 and with RAND's own survival as an organization; and the outcome of its use as a means to coordinate institutional and political interests.

This dissertation will trace the changing experiment in remaking the postwar Air Force and its relations with industry and academia through an institutional invention, RAND. At the center of analysis will be the specific ways in which RAND and the Air Force sought to achieve this end. We will see how the practices of science and technology at RAND both responded to and resisted Air Staff interests for constituting a service political economy in the postwar period. More broadly, we will see how RAND and the Air Force in their relationship through 1950 both drew on and contributed to political traditions of defining relations between the state and the market.

Chapter I

"A Long-Haired Air Force?":
Hap Arnold, Edward Bowles, and Planning for Science and Technology

This chapter will focus on the prewar and wartime backgrounds that informed Army Air Forces Commanding General Henry "Hap" H. Arnold's decisions to adapt his institution's culture to the primacy of science and technology in service life. The related task of legitimizing and holding together a political economy comprising the service and external sources of science and technology will be covered in subsequent chapters. The interconnection between changes in Air Force organization over the years 1945-1947 and Arnold's push to firmly integrate science and technology into the service has been little studied. Good accounts exist on service planning and organizational changes as well as on one aspect of Arnold's interest in science--the establishment in 1944 of the Science Advisory Group (SAG), headed by Theodore von Karman--but not on their close interrelation nor on their connection to larger policy debates, particularly the questions of independent status for the Army Air Forces and of establishing a National Research Foundation (NRF).[1]

1. On planning and organization the best accounts are Perry McCoy Smith, *The Air Force Plans for Peace, 1943-1945* (Baltimore: Johns Hopkins University Press, 1970) and Herman S. Wolk, *Planning and Organizing the Postwar Air Force* (Washington, D.C.: Office of Air Force History, 1984). On the Science Advisory Group see Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944-1964* (Washington, D.C.: Office of Air Force History, 1967).

RAND would become an integral part of Arnold's postwar vision; it was conceived as a response to challenges of internal reform and of the service's perceived need for close ties to industry and academia. Two individuals stand at the forefront of this story in the period 1945 through 1947. One is Arnold; the other is Edward L. Bowles, a Massachusetts Institute of Technology (MIT) professor of communications who served as Expert Consultant to Secretary of War Henry Stimson beginning in 1942, and then broadened his advisory and management activity to become Special Consultant to Arnold, Commanding General of the Army Air Forces, in 1943. Each man played a specific role in the effort to change the service's internal organization of science and technology and its relations with academia and industry. Arnold's contribution, as Commanding General of the Army Air Forces, was predominantly rhetorical and ideological. He set the broad terms of action, articulating a world view and pushing specific projects to realize that view. Bowles was one of those tasked to amplify Arnold's vision and, perhaps more important, to execute projects that gave it concrete meaning.

Arnold and Postwar Planning

In January 1945 Army Air Forces Commanding General Hap Arnold addressed about 250 of his officers at their Pentagon headquarters. The subject was science, technology, and service organization in the postwar period. James F. Davenport, a lieutenant colonel, and Thomas C. Rives, a brigadier general, were present and afterward set down their impressions. Arnold sought to stir his senior officers to the changes war had brought to the air corps, changes that had reordered the institution's guiding assumptions. The time had come to think intensively about the postwar period. Arnold thought a reconceptualization of these assumptions and past practices was required--in management, in institutional culture, and in the Army Air Forces's relation to sources of science and technology.

Arnold's first call was for a seemingly simple organizational act, separating day-to-day operations--the direct business of conducting the war--from planning. Headquarters, to this point, had been an intimate participant in theater operations, to the extent of "knowing every type of airplane and where each airplane, by serial number, was on each day."[2] As one step to separate operations from planning, Arnold established a new Continental Air Forces (CAF) responsible for several tasks: air defense operations in the United States, pilot training, managing redeployments of aircraft and troops from Europe to Asia, and standing as a reserve strategic force. It would fulfill its mission without the detailed direction of Arnold and his headquarters staff.[3] If there were even "passive resistance" to this division of labor between operations and planning, Arnold "wished to advise all that he would, if necessary, issue a directive that 2,000 officers from this Headquarters would be transferred to the Continental Air Forces tomorrow morning."

2. Memo from Rives to Gen. McClelland, 14 January 1945, p. 1, Folder "12107-pwp-other talks by H.H. Arnold," Box 1, Bowles Papers, NASM.

3. For most of the war the First through Fourth Air Forces were responsible for fulfilling these functions. Creation of the CAF established a managerial layer between these forces and headquarters. On the establishment of the CAF see W.F. Craven and J.L. Cate, *The Army Air Forces in World War II*, Volume VI: *Men and Planes* (Washington, D.C.: Office of Air Force History, 1983), p. 75.

According to Arnold, the previous blurring between day-to-day operations and headquarters planning activity had resulted in a lack of attention among leadership to the problems of the Air Forces "five, ten, twenty years away." Headquarters, henceforth, should "be filled with a group of thinkers, thinking of the future Air Forces."[4] This should be its only function.

The need for this division of labor was rooted in the war experience itself. Arnold directed his audience to the new realities that marked the present and would dominate the future. Two were crucial. The war had made the Air Force a global institution, and postwar conditions would only intensify the service's far flung responsibilities. Indeed, such expanded scope was part of Arnold's strategy to ensure the future of his institution. Arnold championed the notion that the Air Forces "will perform police duties on a worldwide basis" in the unsettled aftermath of the war.[5] With such responsibility looming, headquarters leadership needed to focus on the material and institutional elements of the job. How many aircraft would be required? What kind? Where should air bases be located around the globe? The ability to define and answer such questions would be the basis for shaping the Army Air Forces political role and standing. Arnold noted that "if these decisions are not made by the Army Air Forces staff they will be made by the Russians and the British and the final decisions that will take place in the world council of nations will be crammed down our throats and we will have to take it,

4. Memo from Rives to Gen McClelland, 14 January 1945, note 2, p. 1.

5. Davenport memo for the record, 14 January 1945, p. 2, folder "12107-pwp-other talks by H.H. Arnold," Box 1, Bowles Papers, NASM.

like it or not."[6] Looking to the future was an essential part of defining and securing the service's postwar role--especially as a force independent from but equal to the Army and the Navy in the military establishment.

This institutional and political argument was linked to another seminal shift brought about by the war: the advance of technology. Arnold reminded his audience of the dramatic improvements in aircraft, from the P-40 fighter to the P-51, from the B-17 bomber to the B-29, and to the unprecedented applications of radar. Arnold enjoined his officers to think 25 years into the future. He visualized "the next war would not start with a naval action nor air action by aircraft flown by human beings, that it might very well start with missiles being dropped on the capital of a country, say Washington, at the rate of 5,000 of these missiles a day; that not one of these missiles would contain a human being."[7] The war, in Arnold's thinking, inaugurated a new order: an ongoing, relentless process of technological obsolescence and innovation. And technology relating to air had a special place in this new order. The long-range bomber and the fledgling missile made possible war of devastating impact with short warning. The defining balance in the next war would be the technologies of air. The instrumentalities of land and sea battle would be secondary in this new age. Nations, including the United States with its historically advantageous geographical siting, could suffer decisive losses even before war was officially declared. Obsolescence and innovation here,

6. Ibid.

7. Memo from Rives to McClelland, note 2, p. 2

then, had special consequences. The former spelled a national peril; the latter promised survival.

But the challenges of obsolescence and innovation were not abstract and distant or confined to the realm of planning. Arnold perceived them as immediate and profound, affecting the core of his institution's practices and culture. The Army Air Forces of the prewar and war years was built around the pilot and around crafting distinctive roles for airplanes in warfare. The ascendance of the pilot in service culture was rooted in nearly two decades of effort to link the fate of the Army Air Corps as an institution with a doctrine of strategic bombing. As stated by Arnold later in 1945, "Strategic Theory, as applied to the United States warfare concept, postulates that air attack on internal enemy vitals can so deplete specific industrial and economic resources, and on occasion the will to resist, as to make continued resistance by the enemy impossible."[8] During the war only pilots and airplanes could operationally implement the theory's premise, destruction of an enemy's "vitals." Prewar and wartime developments in airplane technology made possible this identification of a pilot-dominated institutional culture with a doctrine of warfare. Now Arnold opened up the contingent assumptions of this identification. New technologies, such as the guided missile, offered the possibility of fulfilling the ends of strategic theory without the means--pilots and airplanes. The changes Arnold foresaw thus were a potential threat to the special status of pilots in the service.

8. *The War Reports of General of the Army George C. Marshall...General of the Army H.H. Arnold...Fleet Admiral Ernest J. King* (Philadelphia: Lippincot, 1947): p. 456.

Both of these hallmarks of the coming postwar period--institutional self-definition and an ideology of innovation--would necessitate changes in institutional culture. This was especially true if the Army Air Forces were to achieve its long-sought goals of independence from the Army and equal standing with that service and the Navy. The independent Air Force of the postwar period, Arnold reasoned, would have to be an amalgamation of different professional cultures--the pilot, the technologist, and the business person. Management, planning, policy, specialized knowledge--dry, unheroic subjects--would be at least as institutionally essential as the exploits of the pilot. The purpose of addressing the headquarters staff in January 1945 was not just an opportunity for Arnold to reinforce ideology or rally his colleagues to the challenges of the future. It was largely to confront an institutional irony. For Arnold it marked the beginning of the end of a pilot-dominated air force culture in which pilots, planes, and a theory of strategic bombing had become the organizing principles. The demands of international operation and relentless technological advance called for new institutional values and new modes of organization. The irony was that in the 1920s and 1930s Arnold himself was one of the service leaders most responsible for creating the pilot as a distinct kind of warrior meriting a separate institution, culture, and disciplines of professionalization.[9] Now, as he reflected on the postwar status of the Army Air Forces, Arnold sought to reconfigure the relations between institutional culture and the ideology of strategic bombing. Lt. Col. Davenport captured Arnold's thoughts on this in the first person:

9. This point is examined in more detail in the next section of this chapter.

> The Air Force in the future must not be built solely around pilots. I will not have a part of it and I, who was responsible for the building of our Air Force around pilots, realize that this policy must change if we are to keep the United States free from attack and destruction by being so far ahead of the other nations in the future that they will dare not attack us....I maintain that any Air Force which does not include the most technically able personnel to form the nucleus, around which to build the Air Force of the future, such an Air Force is doomed to failure and I want no part of it.[10]

Brigadier General Rives, who also was in attendance, brought forward different nuances of Arnold's presentation:

> ... the Air Force of today was conceived and built around the pilot as absolutely essential. He stated that he was one of the proponents of that belief and succeeded in having enacted laws which practically made it impossible for other than a pilot to occupy positions of responsibility in the Air Forces. We are now passing into another phase where the pilot will no longer be the controlling factor. It is those people who can think and produce for the air forces the types of aircraft, armament, radar, etc., and can implement the use of those equipments that will be of value to the Air Forces in the future. The pilot can no longer be the commanding feature. He stated that he saw little value in the fact that a man wore wings on his coat if he could not conceive of the type of thinking that he had described; that he would prefer to have an Air Force built up of long-haired individuals, who had no wings, and could conceive of these things and keep ahead of the enemy, than one of pilots; that the future Air Force need not in itself have one single individual in any of its aircraft.[11]

Perhaps Arnold's zeal for promoting a new conceptual basis for the service was intended to be proportionate to the resistance he knew he would meet from the many pilots in his audience. A culture centered on pilots was never displaced completely and only changed in increments as science, technology, and guided missiles were more thoroughly integrated into service life through the 1950s. His strong

10. Davenport memo, note 5, pp. 2-3. Davenport's cover page to Arnold's talk indicated that his summary was not verbatim and that he had written them in the first person to convey the strength of Arnold's presentation.

11. Memo from Rives to Gen. McClelland, note 2, pp. 2-3

words, though, were not mere drama. Arnold believed the war experience and changes in technology undermined existing institutional culture. The prospects were unsettling for Arnold's military professionals. Arnold confronted them with the possibility of "long-haired individuals," scientists and other academically-trained professionals, with their specialized skills and culture, supplanting them as the backbone of the service they had worked so hard to create. This prospect was part hyperbole. Arnold's respect for the scientific community had distinct limitations. The metaphor of the "long-hair" was to suggest the divide between military and scientific professions, capturing differences in goals, ethos, and work practices between the two communities. What was not hyperbole was Arnold's perception that science and technology would be key in defining the service's culture, its strategies for war, and its success as an independent institution.

But this understates the problem Arnold was trying to convey. It was not only a matter of psychological adjustment or of refashioning the service to be more accommodating to science and technology. Arnold's remarks were intended to drive home to the service's future leaders the new organizing assumptions for air war. The importance of new weapons and their modes of research, development, and production had two implications. One was internal and the subject of his exhortations: science and technology were equal to or more important than the doctrine of pilots and strategic bombing as a basis for defining the institution in the future. The service in its operations, incentives, expenditures, and organization would have to reflect this.

The other consequence was external. The new weapons were a product of a particular political economy. The service provided funds and policy guidance, and universities and industry performed research, development, and production. This political economy was not new: the prewar relations between the service and the private sector were close and symbiotic.[12] But wartime and ideology deepened and broadened these connections, in practice and in the language used to describe them. If the service was to fulfill the role outlined by Arnold, science and technology were now necessary, integral resources. They were the bedrock of the service's present and future ability to wage war. The heightened role of science and technology in war had already created *de facto* a new political economy built around institutions and professionals external to the service and adept in knowledge and practices essential to the new weapons production. The challenge would be to sustain this new political economy. This task was especially crucial for the Army Air Forces and its aspiration for independent status as a service. As the youngest of the military arms, it had, compared to the Navy and Army, a modest system of research and development laboratories and no network of arsenals.[13] Historically,

12. This prewar relationship has been examined from several perspectives. On the Congressional role in defining the military industry see, for example, Jacob Vander Meulen, *The Politics of Aircraft: Building an American Military Industry* (Lawrence, KS: University Press of Kansas, 1991). On the government role in supporting research and development, see Alex Roland, *Model Research: The National Advisory Committee for Aeronautics*, Volume I (Washington, D.C.: NASA, 1985): chapters 1-7. On the role of military contracting practice, see Irving B. Holley, Jr., *Buying Aircraft: Materiel Procurement for the Army Air Forces* (Washington, D.C.: Office of the Chief of Military History, Department of Army, 1964), chapters 1-6.

13. For insight into the weak state of Air Force R&D after the war see "Research and Development in the United States Air Force: Report of a Special Committee of the Scientific Advisory Board," September 1949, Office of Air Force History.

the Army Air Forces relied on the aircraft industry and the National Advisory Committee for Aeronautics (NACA) as the principal sources for research and development. To accomplish this, Arnold would have to navigate the entrenched practices and expectations of his own service, as well as the differing interests of scientific, industrial, and various governmental communities. How could the essential resources of science and technology be readily available to the service in postwar years? Within the constraints of American political tradition, what understandings could be crafted to meet the perceived needs of leaders such as Arnold?

Arnold, Preparedness, and Air Power

Arnold's beliefs and his expressive rhetoric were instrumental in shaping the postwar service. He was one of the founding members of the air service when it was created in 1907 as the Aeronautical Division, Office of the Chief Signal Officer. He grew up with the service, participating in the development of military aviation, the articulation of air doctrine in the 1920s and 1930s, and debates over service autonomy in relation to army and navy forces. By the time Arnold was appointed as Commanding General of the Army Air Forces in 1942, his views and aspirations for the service were well developed. World War II, especially the impacts of science and technology, only strengthened the connections among innovation, a doctrine of strategic bombing, and an independent service.[14]

14. The best account of Arnold and the service before and during the war is Michael S. Sherry, *The Rise of American Airpower: The Creation of Armageddon* (New Haven: Yale University Press, 1987). A hagiographic but useful biography is Thomas M. Coffey, *Hap: The Story of the U.S Air Force and the Man Who Built It, General Henry H. "Hap" Arnold* (New York: The Viking Press, 1982). Arnold's biography, unfortunately, provides little insight into his interest in the role of science in the Army Air Forces; his personal account concludes with the end of the war and, hence, does not cover his and Bowles's effort to establish

World War I and its aftermath brought marked changes to the air service and were instrumental in shaping Arnold's views. On the eve of U.S. involvement in 1917 the Aviation Section of the Signal Corps had 131 officers, just over 1,000 enlisted men, and fewer than 250 airplanes, all trainers. Anxious allies and a public enthusiastic over flight called for a much larger air presence as part of U.S. entry into the war. In response Secretary of War Newton Baker supported a plan to produce more than 22,000 military planes and 40,000 engines--an ambitious program when, from the first Wright flyer in 1903 through 1916, the American aircraft industry had produced only 1,000 military and civil airplanes. To handle this massive surge in production in 1917 Congress created the Aircraft Production Board (APB), which, like other institutions of the war such as the War Industries Board (WIB) and the National Research Council (NRC), provided crucial experience in collaborative planning between government and the private sector.[15] In the end, under the direction of the APB, industry produced approximately 14,000 planes and 32,000 engines.

RAND. See Henry H. Arnold, *Global Mission* (New York: Harper and Brothers, 1949). On Arnold's leadership style, see J.W. Huston, "The Wartime Leadership of 'Hap' Arnold," in *Air Power and Warfare*, eds., A.F. Hurley and R.C. Ehrhart (Washington, D.C.: Office of Air Force History, 1979):168-185. A recent account of Arnold's relationship with Theodore von Karman in establishing the Scientific Advisory Group is Dik Daso, *Architects of American Air Supremacy* (Maxwell AFB: Air University Press, 1997).

15. On the War Industries Board as a model for cooperative government-business relations to regulate markets see Robert Cuff, *The War Industries Board: Business-Government Relations During World War I* (Baltimore: Johns Hopkins University Press, 1973); on the WIB and APB as precedents used in exploring cooperative arrangements between government and industry in the 1920s see Ellis Hawley, *The Great War and the Search for a Modern Order: A History of the American People and Their Institutions, 1917-1933* (New York: St. Martins Press, 1992).

But the war experience did not lead to a dramatically invigorated air arm, as advocates like Arnold had hoped. The results for the air effort were mixed. The production program during the war suffered through mismanagement and delay, and, ultimately, the contribution of American military air to the war was marginal. These failures and unfulfilled promises led to charges of industry profiteering and warmongering that lingered through the 1930s.[16]

At war's end orders for more than 10,000 planes and 20,000 engines were canceled. Ninety percent of industry production capacity was liquidated. By 1920 the number of Air Service personnel decreased from 200,000 to less than 10,000. This retrenchment to "normalcy" was not unexpected, but it left unresolved the role of the Air Service within the Army, particularly over the question of whether an air arm was principally an adjunct to ground warfare or a separate force with a distinct role in war. Through air advocates such as Billy Mitchell, Assistant Chief of Air Service, 1920-1925, the service sought a distinct and specialized mission built around strategic bombing--waging war on an enemy's industrial and transportation assets--and an independent organization separate from the Army and Navy. Arnold was a vocal proponent of Mitchell and his ideas. But Mitchell's continued and pointed criticism of the military for its weak support of aviation led to a court martial in 1925 and his departure from the Air Corps in 1926. Peacetime also left unresolved the role of government in supporting the aircraft

16. On these charges and their relevance to Congressional arguments over military funding and support for the aircraft industry in the prewar period, see J. Vander Meulen, *The Politics of Aircraft*, note 12.

industry through military contracts or through stimulation of civilian commercial aviation.

These issues were worked out, hesitantly and in awkward steps, in the 1920s and 1930s. From 1920-1925 more than a dozen studies and commissions were convened by either Congress or the executive branch to recommend policies on these points and on the government role in civil aviation. The 1930s brought more high-level reviews. All of these grappled with a basic challenge: the airplane was a technology that had potential for both government and private market uses, but the young industry and entrepreneurial inventors alone seemingly could not aggressively develop its possibilities. Public enthusiasm for flight and a broad perception that the airplane could transform commerce and international relations stimulated these ongoing reviews and reorganizations of the nation's approach to aviation, including military air.[17] The military, industry, and governmental interest in the role of the airplane in national life tested notions of politically acceptable forms of organization and laws for defining the government-market relationship. Cooperative planning arrangements between government and industry were preferred.[18]

17. One of the best accounts of aviation in this period is Joseph Corn, *Winged Gospel: The American Romance with Aviation, 1900-1950* (New York: Oxford University Press, 1983).

18. In the early 1920s, during this period of intensive review of military and commercial aviation policy, some members of the aircraft industry called for nationalization as a way to overcome their problems. On the preference for cooperative approaches over state control, see David D. Lee, "Herbert Hoover and the Development of Commercial Aviation, 1921-1926," *Business History Review* 58 (1984):79-102, and Ellis Hawley, "Three Facets of Hooverian Associationalism: Lumber, Aviation, and Movies, 1921-1930," in *Regulation in Perspective, Historical Essays*, ed. Thomas K. McCraw (Boston: Harvard University Press, 1981):95-123.

Such considerations, for example, informed the creation of the APB during the war and earlier, in 1915, the establishment of NACA. Within a few years, NACA developed into a government laboratory complex devoted to research on the theory and technologies of flight. Support for research demonstrated government encouragement to the fledgling technology but did not interfere with the prerogatives of industry. Moreover, NACA's elaborate committee system provided a means for military, industry, and university interests to participate cooperatively in its research program.[19]

The Morrow Board, created by President Coolidge in 1925 and headed by Dwight Morrow, was perhaps the most significant review board to address military air interests and their relation to a struggling aircraft industry. Based on its recommendations, the Air Service was elevated in status with greater control over budgets and defining its mission, and renamed the Air Corps, in recognition of "military aviation as an offensive, striking arm rather than an auxiliary service." Army leadership and Congress also committed to a five-year procurement program to increase the inventory of military planes and support the aircraft industry. But, in the following years, Congressional appropriations were less than promised and procurement goals were not met due to the lingering charges of industry profiteering and warmongering.

19. On NACA and its role in the development of aviation in the 1920s and 1930s, see Alex Roland, *Model Research*, note 12, especially chapters 3-7, volume 1. It should noted that for the Air Corps, in particular, NACA compensated for a near absence of laboraory facilities in the service.

These policy issues also intertwined with the course of research and development. After the war, reduced budgets and Congressional requirements that the military utilize war surplus planes and engines thwarted Air Corps efforts to develop bombers and improved engines suitable for strategic bombing.[20] The Liberty engine came to symbolize, for Arnold and the Air Corps, the backwardness of government policies toward military aviation. Developed during the war, the Liberty engine was a reliable, successful power plant and was produced in great number. After the war, the service was compelled to use the surplus well into the 1930s, hampering the development of more advanced engines through procurement. Not until 1935, when the B-17 bomber, championed by Arnold, began test flights would the Air Corps have an aircraft suited to fulfill the strategic bombing mission. Research and development were also compromised by procurement regulations that were introduced as part of the 1926 legislative reforms. These regulations created a complex, bureaucratic maze for aircraft purchases, emphasized procurement on the basis of lowest cost and best performance, and made manufacturers responsible for most research and development costs. The result for industry was time delays in procurements and slim profit margins. While beneficial for Air Corps, these regulations made it extremely difficult for industry

20. This situation was mitigated by the research and engineering work of NACA, established in 1915. Through the 1920s NACA improved the character of its research laboratories and contributed a number of advances to aircraft and engine design and to the empirical basis of aerodynamic theory. The Navy and Army were represented on NACA's governing board and transmitted service problems and requests for research. NACA research was about evenly divided between work for the military and for the aircraft industry. See Alex Roland, *Model Research*, note 12.

to profit from military business and achieve a sound financial footing. Still, through the 1930s the military was the largest source of sales for manufacturers.[21]

The inauguration of the B-17 coincided with another review of the Air Corps, the Baker Board, which resulted in the creation of the General Headquarters Air Force. This was an operating command directly responsible to the Army Chief of Staff and with a mission explicitly defined as strategic bombing. The Air Corps remained a separate organization responsible for supply and procurement.[22] Arnold's career had progressed along with these halting technical and institutional advances for the service. In 1935, as brigadier general, he commanded the 1st Wing of the General Headquarters Air Force at March Field, California. He had been stationed there since 1932 and already had developed close ties to the leaders of the southern California aviation industry, particularly Donald Douglas, head of Douglas Aircraft.[23] In 1938 Arnold was appointed Chief of Air Corps; after further reorganizations and the beginning of World War II he was appointed Commanding General, Army Air Forces.

21. The best account of aircraft procurement from the Morrow Board through World War II is I.B. Holley, *Buying Aircraft*, note 12. On the 1920s and 1930s see chapters 1-6.

22. Holley, *Buying Aircraft*, note 12 gives the most lucid account of these changes as well.

23. On Arnold's friendliness with leaders of the aircraft industry before and during World War II see oral histories conducted as part of the "General H.H. Arnold Project," Columbia Oral History Research Office, Columbia University. See in particular the interviews with Donald Douglas and Arthur Raymond.

World War II enabled Arnold and other advocates of an independent air force and strategic bombing to advance their cause directly within the War Department, with President Roosevelt and later President Truman, Congress, and the American public. Roosevelt's call to produce 50,000 aircraft in spring 1940 initiated an immediate expansion in the aircraft industry and in the Army Air Forces. In 1936, the industry sold just over 1100 aircraft to the military; in 1939 approximately 2100. From the middle of 1940 through 1945 the industry delivered more than 160,000 aircraft to the Army Air Forces alone. All military aircraft sales over the period 1939 to 1945, including the Navy and foreign governments, totaled more than 320,000 planes. In the 1930s the aircraft industry was a small fraction of the country's industrial base; by the end of the war it was the largest economic sector, exceeding in size the automobile industry. Air service expenditures for research and development, which had been modest before the war, totaled more than $600 million from 1942 through August 1945. The number of personnel increased, too, during the war, from 22,000 to over 2.5 million. Commensurate increases occurred in the number of civilian personnel working with the Army Air Forces. As an example, before the war there were less than 2,000 civilians assisting with procurement; at the height of the war effort nearly 40,000 were employed.[24]

24. Statistics from Holley, *Buying Aircraft*, note 12, chapter 21. The best overall account of the service in World War II is W.F. Craven and J.L. Cate, *The Army Air Forces in World War II* Volumes I-VII (Chicago: University of Chicago Press, 1948-1958). The volume most germane to these discussions is Volume VI, *Men and Planes*, note 3.

The air campaigns in Europe and Asia were generally regarded as successful demonstrations of strategic bombing--if not always entirely effective in destroying enemy industry and transportation networks, at least such bombing suggested its potential as a mode of warfare in the future. The prosecution of the air war and the integration of the air effort into the nation's political and economic fabric created a broad base of public and political support for the Army Air Forces--and for its interests in autonomy, strategic bombing, and maintaining a vibrant aircraft industry. This stood in marked contrast to the travails, as perceived by service leadership, of the 1920s and 1930s. Arnold and the Army Air Forces were determined to sustain this high level of support in the postwar period.

As with the Navy and Army, the Army Air Forces began planning for a postwar service soon after U.S. entry into the conflict. Postwar planning was a highly contentious undertaking, with the services and scientific community pushing for particular prescriptions on military organization, force strength, research and development, and support for academic science. Planning for the respective postwar roles of the Army Air Forces and the Navy in military air was divisive, and would be complicated further by the question of which services would be responsible for delivering the atomic bomb in the postwar years.[25] In 1943 Arnold established the Post War Division to develop service requirements after the end of hostilities--and to represent service interests in the bureaucratic struggles. As an

25. Before the war Congress had established the Aeronautical Board to coordinate Air Corps and Navy interests in developing aircraft. The board which continued through the war did little to address or ameliorate the competing claims of the two services. See Holley, *Buying Aircraft*, note 12.

element of the Army, Arnold and the air service also were actively involved in Army postwar planning, exposing tensions there as well.

Congress also looked ahead during the war. The House Select Committee on Postwar Military Policy (known as the Woodrum Committee) held hearings during the last year and a half of the war, showing special interest in questions of weapons development and unification of the services. The question of research and development was also on the minds of the scientific community and of a military which had come to appreciate the role of science in weapons developments. Radar, proximity fuzes, rockets, the atomic bomb, and other advances all signaled the heightened role of technological advance in preparing for modern war and the need to continue close ties among the military, industry, and universities into the future.

But deliberations on postwar research and development would have a distinct character. Demobilization after the war would surely reduce dramatically the size of the Army Air Forces and procurement budgets supporting the aircraft industry. The questions of the size of a postwar air force and of procurement budgets were part of a political give-and-take that was familiar and had a rich history. The place of university-based research in demobilization hinged on whether academics would continue to be interested in military work, and, if so, on what terms. In the 1920s and 1930s universities looked primarily to foundations and industry to support research. The academic community viewed government support, including military, cautiously, concerned by the possible intrusion of politics into the university.[26]

With World War II perceptions on the propriety of government and military support to universities changed markedly. Both sides looked to continue, in some fashion, wartime patterns. In planning for the postwar, both the military and scientific leadership sought to balance traditions of research independence and the close working relationships required to develop weapons and other devices. This informed the organization of the Office of Scientific Research and Development (OSRD), headed by MIT's Vannevar Bush. It was OSRD, in a close partnership with the military, that produced most of the war's successful science-based weapons and devices. Yet OSRD was organizationally independent from the military with a separate appropriation. Bush insisted also that OSRD, created specifically to assist with the war effort, was a temporary organization that should go out of business soon after the cessation of hostilities. It seemed, for the same reason, that many of the university laboratories created during the war by OSRD would also disband. For example, Karl Compton, president of MIT and a member of the OSRD Advisory Committee, planned to shutter the MIT Radiation Laboratory, the most prominent wartime research laboratory.

26. The most useful general accounts on the evolution of funding to universities from foundations, industry, and government are two companion pieces by Roger Geiger. On prewar developments see *To Advance Knowledge: The Growth of American Research Universities, 1900-1940* (New York: Oxford University Press, 1986); on postwar developments see *Research and Relevant Knowledge: American Research Universities Since World War II* (New York: Oxford University Press, 1993).

This prewar and wartime history demonstrated the differences in perspective that separated the scientific community, the military services, Congress, and the President in articulating specific postwar arrangements. In 1944 Secretary of War Henry Stimson and Secretary of the Navy James Forrestal jointly appointed the Committee on Post-War Research, headed by industrialist Charles E. Wilson.[27] The committee's deliberations helped establish in late 1944 the Research Board for National Security (RBNS) with the hope that the collaborative relationship between the military services and the scientific community developed through OSRD could be translated to peacetime. The board operated under the auspices of the National Academy of Sciences (NAS) to ensure that scientists and their research would be insulated from government controls. The proposal soon collapsed over this very issue: Congress and the executive branch could not properly monitor appropriations administered by a private organization.[28] Also in 1944 President Roosevelt, with Bush's encouragement, asked Bush to study the government-science relationship, which led to his July 1945 *Science: The Endless Frontier* and a recommendation for a National Research Foundation, again promoting an independent institution for scientists. Arnold, too, mulled the same question and, in November 1944, as a response to the pending Bush study, asked Theodore von Karman to examine the role of science and industry in a postwar air force. While supportive of strengthening national scientific capabilities, Arnold also was determined not to have to

27. On the Woodrum and Wilson Committees see Michael Sherry, *Preparing for the Next War: America Plans for Postwar Defense, 1941-45* (New Haven: Yale University Press, 1977).

28. On the RBNS see Daniel Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944-1946," *Technology and Culture* 16 (1975):20-47.

rely on an RBNS or NRF for service research and development. Rather, Arnold pushed to ensure that the Army Air Forces had its own scientific assets--either internally or through contract.

While postwar planning highlighted the adversarial process of defining the organization of the postwar military establishment and of science, it also demonstrated the breadth of support for Arnold's ambitions for the Army Air Forces. Presidents Roosevelt and Truman strongly endorsed an independent service and the primacy of a strategic bombing capability in the postwar period. George Marshall, Army Chief of Staff, was also sympathetic to service objectives.[29] Vannevar Bush, too, favored a prominent place for a postwar air force. He wrote Arnold in June 1944 to suggest the establishment of a board, using the 1925 Morrow Board as a model, to examine the specific challenges of postwar aviation, particularly with respect to government encouragement of industry and to aviation research and development. Bush thought the complexities of aviation could not be adequately examined by the Woodrum and Wilson Committees.[30] As in the 1920s, the importance of and interdependent relations among the aircraft industry and civil and military aviation seemed to require a special review, which was beyond the purview of the wartime committees. The outlines of such a broad

29. On the breadth of support for the Army Air Forces and strategic bombing see Sherry, *The Rise of American Air Power,* note 14; Sherry, *Preparing for the Next War*, note 27; Steven Rearden, *The Formative Years, 1947-1950, History of the Office of the Secretary of Defense, Vol 1* (Washington, D.C.: HO, OSD, 1984); Melvyn Leffler, *A Preponderance of Power: National Security and the Truman Administration in the Cold War* (Stanford, CA: Stanford University press, 1992).

30. Letter from V. Bush to H. Arnold, 9 June 1944, File "JNW Chronological 7/21/43...," Series 343A, RG 218, NARA.

review were already tentatively underway. An informal committee composed of members from the State, War, Navy, and Commerce Departments and the Civil Aeronautics Board began meeting in mid war to consider postwar aviation policy. At the urging of Robert Lovett, Assistant Secretary of War for Air, this planning effort was formalized through the establishment of the Air Coordinating Committee in March 1945.[31] The industry, too, through its trade organization, the Aircraft Industries Association, planned for the postwar period.[32]

During and just after the war Arnold sought to sustain this support and counteract those (particularly the Navy and, to some degree, Bush, on the question of control of research and development) who resisted the service's quest for autonomy and the primacy of strategic bombing in postwar planning. To meet this challenge, Arnold honed a vigorous rhetoric that laid out his prescription for the postwar period. An examination of this rhetoric will help to illuminate the role of the nascent Project RAND in Arnold's thinking in fall 1945.

Arnold's exhortations to his officers in January 1945, cited at the beginning of this chapter, reflect his ideology, revealing a complex of mutually reinforcing beliefs and attitudes that were expressed repeatedly through the rest of the year. In the foreground is what Michael Sherry has dubbed an ideology of preparedness, a

31. For a brief description of this undertaking see George A. Brownell, "The Air Coordinating Committee: A Problem in Federal Staff Work," *Journal of Air Law and Commerce* 14 (1947):405-435.

32. See note 38.

commitment to be militarily ready for the next international conflict.[33] Arnold himself referred to this belief in much the same way:

> "The nation that is prepared to use the superplane and the super-explosive of the future may win a war as soon as it starts. The preservation of peace by us depends on two factors. One factor is a national psychology of readiness--with the most powerful and effective modern weapons--a willingness on the part of our citizens and our Congress to prepare and use our Armed Forces--to provide for the security of our nation. The other factor is having in being balanced Armed Forces--built up to such strength and so located to cause all nations to stop, to look, and to think."[34]

In Arnold's view, his experiences and those of the nation before and during the conflict warranted a commitment to military readiness. The Air Corps's frustrated ambitions in the interwar years, the trauma of Pearl Harbor, the international instabilities created by war, and the belief that the United States, as the world's preeminent power, would be the first target in the next conflict all pointed, in the thinking of service leadership, toward an imperative of continual readiness. The changes in war brought about by improvements in air technologies only accentuated the lessons of the past. Constant innovation made the problem of preparedness more immediate, urgent, and yet provided the avenue for resolving the problem with increased and continuing technological effort on the part of the service.[35]

Arnold's blunt address to his officers in January 1945 came before the atomic bomb had become the dominant symbol of science and engineering applied to war,

33. Michael S. Sherry, *Preparing for the Next War*, note 27.

34. Transcript of Arnold speech to members of the Pennsylvania Society, 8 December 1945, p. 5, File 4, Box 237, H. Arnold Papers, Library of Congress

35. On these points see Sherry, *The Rise of American Airpower*, note 14.

amplifying the argument of preparedness. The basis of an ideology of preparedness was an extrapolation of the past and the wartime present to the still unknown postwar world. No specific enemy or international threat anchored it. The fitting of this ideology to conflict with the Soviet Union would be made in steps over the next several years.[36] The primary work of an ideology of preparedness in early 1945 was on the home front: to secure the political and institutional future of the Air Force. The concrete realization of this work would be to make the Army Air Forces an autonomous service equal in political standing with the Army and Navy.

Arnold presented his psychology of readiness as an encapsulation of his service's past and present experience. Yet it was only a first step in working through his assessment of the service and the state of the postwar world. Another concept--air power--was a staple of Arnold's speeches during 1945. The phrase "air power" gained prominence in the 1920s in the writings of proponents of strategic bombing. In its early usage, air power emphasized the potential of the airplane as a military tool and as an instrument of national policy. It was a counterpoint to the concept

36. In this regard two different levels of planning and policy need to be distinguished in identifying the Soviet Union as Cold War foe. One was policy as formulated by the President, State Department, and (later) the National Security Council. The Soviet Union as threat crystallized in a series of steps from late 1945 through spring 1950, when NSC-68 was formally approved. The other forum germane to assessment of the Soviet threat was Joint Chiefs of Staff war planning. As early as late 1945 war plans identified the Soviets as a possible adversary; by spring 1946, after confrontations over Iran and Turkey, war plans were developed on the premise that war with the Soviet Union was possible in the near future. Much has been written on the process leading to NSC-68. One of the best general accounts is Melvyn Leffler, *A Preponderance of Power: National Security, The Truman Administration, and the Cold War* (Palo Alto: Stanford University, 1992). On war planning a masterful account is Eduard Mark, "The War Scare of 1946 and Its Consequences," *Diplomatic History* 21 (1997):181-215.

of "sea power" as developed by naval theorist A.T. Mahan.[37] Arnold expanded the meaning of air power and used it as shorthand for a prescription of institutional and political actions to ensure readiness. By the end of the war the notion of air power was a staple in the speeches and writings of the broad community that supported the Army Air Forces.[38]

The airplane itself and its "weapons of total destruction" were only the proverbial tip of the air power iceberg. Arnold thought "the average man is handicapped in his thinking about air power by the fact that he has seen no essential change in the outward appearance of aircraft in the last ten years. He finds it difficult to grasp the fact there has been a revolutionary change in the performance of aircraft and in the meaning of airpower. It is not easy to grasp the implications of that change."[39]

The psychological implication was a national ideology of readiness; the institutional implication was a political commitment to organize and sustain all the resources necessary for American preeminence in the air. Arnold identified several elements which composed an outline for action to meet this commitment.

37. On the history of the concept of air power see Eugene Emme, *The Impact of Air Power: National Security and World Politics* (New York: Van Nostrand, 1959).

38. A typical example is Eugene Wilson, *Air Power for Peace* (New York: McGraw-Hill, 1945). Wilson was president of the Aeronautical Chamber of Commerce of America (soon to be renamed the Aircraft Industries Association) and echoed the arguments of Arnold on the necessity of a strong postwar air force and aircraft industry.

39. Arnold, note 34, p. 3

This outline recurred with regularity in his speeches and writings through 1945 until his retirement in February 1946. At various times he called for:

> air power in being, the maintenance of the striking air force that the aggressor knows can take off against him on the notice of minutes and hours instead of months and years ...
>
> ...constant and driving research that must never flag. The Air Force will perforce take a leading part in supplying the energy and the means to keep us in front.
>
> ...an aviation industry that is capable of rapid expansion to meet any demand.
>
> ...within the Air Forces trained personnel adequate for rapid expansion
>
> ...[overseas] bases--strategic spring boards from which we can operate effectively.[40]

Occasionally Arnold incorporated universal military training into the political commitment to air power.[41] More important, though, was a close connection between civil and military aviation. In time of emergency they shared or could share many of the same resources: transport planes, airports, trained pilots, an industrial base, and the same deep personal ties to flight. Each sphere of aviation, Arnold thought, needed the other. But both would be necessary to sustain a thriv-

40. Statement by H. Arnold on "The National Hour," 6 January 1946, p. 1, File "Arnold Talks," Box 3, E. Bowles Papers, NASM.

41. Commanding General of the Army George C. Marshall and other officials of the War Department supported universal military training--a national requirement that all young men serve a period of time in military service--as a postwar policy for limiting the size of the military yet still ensuring readiness. Arnold sometimes wavered in his position on this policy. By the end of the war he favored a standing Army Air Forces sufficient in size to meet his conceptions of preparedness. Universal military training, he argued, should supplement this standing force, not replace it. On this debate see Sherry, *Preparing for the Next War*, note 27, and Perry McCoy Smith, *The Air Force Plans for Peace, 1943-1945*, note 1.

ing aviation industry.[42] Arnold also drew into the air power matrix the many private military and commercial aviation associations: "You who see and know the power of air for good or evil must play a large part in fixing our Country's position in the air... you members of the Air Power League, of the Wings Club, of Civil Air Patrol, of Aero Clubs through the Nation hold in your hands our Country's future in the air--*and hence the future of our Country and the World* [Arnold's emphasis]."[43]

Arnold again and again returned to the element of air power he saw as "most important of all": research and development, "ably staffed, adequately financed and properly equipped." Research and development were hedges against future disaster. "If we fail to keep, not merely abreast, but ahead of, technological development, we needn't bother to train any force, and we needn't make any plans for emergency expansion; we will be totally defeated before any expansion could take place." And Arnold had to inform his audiences that research and development, like air power itself, was built on a network of institutional connections linked by "...a movement of research requirements through the Air Force organization and through the civilian agencies helping us with our developments...the endless study

42. This issue embraced a number of interests. By the spring of 1945 the Army Air Forces, the aviation industry, and their lobbying organizations were pushing for congressional and presidential action on the subject. For a revealing summary of the service position with an analysis of their supporters and detractors see Memorandum for General Arnold, 30 June 1945, Series: Official Decimal Files, Folder "SAS 008," Box 59, H.A. Arnold Papers, Library of Congress.

43. Statement by H. Arnold on the "National Hour," note 13, p. 2

and testing and checking, of the huge laboratories, the great testing grounds, the thousands of skilled personnel."[44]

Air power, for Arnold, was a way of life unto itself, its vitality and health essential to the nation in a new age of warfare. It encompassed the service; industry and universities; civil aviation; foreign bases; enthusiasts' associations; the knowledge of officers, scientists, and engineers; and a community of citizens, soldiers, and politicians sharing ideology and goals. Each part supported the others and, if each would join in common cause, they could ensure the place of the service in preparing for future war and defending the nation.

Edward Bowles and the Possibilities of Science and Technology

As a consultant to Arnold and Secretary of War Henry Stimson, Edward L. Bowles, too, was concerned about the postwar world. And, like Arnold, he elaborated an ideology and rhetoric that built on his wartime experience. During 1945 Bowles began to articulate his own conceptions of science, the military, and postwar organization. Bowles's contribution was to extend Arnold's broad arguments on the importance of science and technology in the service and then to translate his insights into specific institutional changes. Arnold's rhetoric identified the social and institutional components essential for air power without offering a specific road map for linking military interests with industry and academia. His primary purpose was to argue for an independent air force. Bowles more directly

44. Address by H. Arnold at Air Force Day Dinner, 1 August 1945, p. 2, File "Arnold Talks," Box 3, E. Bowles Papers, NASM

addressed the political ramifications of the air power concept in his own prescription for postwar organization: "integration for national security."

Bowles gave expression to his position in a March 1945 speech, the title of which, "Integration for National Security," became the motto for his ideology. He stated:

> The course to be pursued is clear; we must not wait for the exigencies of war to drive us to forge these elements [military, industry, and educational institutions] into some sort of working machine, replete with inefficiencies, delays, and the perils induced by discontinuity of action. Rather, we must in peacetime systematically and deliberately couple these elements together so as to form a continuing working partnership, and thereby lay the foundation for maintaining our national security. To be real this relationship must be blessed by mutual understanding of the essentiality of this trinity of interests to our preservation as a balanced, healthy, secure nation. To be successful, this concept must transcend being merely doctrine; it must become a state of mind, so firmly imbedded [sic] in our souls as to become an invincible philosophy. The attainment of this objective must come through inspired education begun in a normal, healthy manner with the young who are capable of assimilating it. A benevolent philosophy thus promulgated will perpetuate itself to engender enduring mutual sympathy and professional understanding.[45]

The basic elements of Arnold's ideology of preparedness and the prescriptions of the air power concept were all present. But more clearly than Arnold, Bowles called for a deliberate political refashioning, ranging from national policy to pedagogical practices and a collective redefinition of citizenship.

Bowles's thoughts were distillations of several years of work with Stimson and Arnold during the war as well as his experiences at MIT as a professor of

45. Edward L. Bowles, "Integration for National Security," speech delivered at Norwich University, 31 March 1945, p.3-4, folder "12097-Address Norwich University," Box 1, E.L. Bowles papers, NASM.

communications engineering in the 1920s and 1930s. At MIT Bowles presided over one of the more ambitious and successful of the university's programs, the Round Hill research center. At Round Hill Bowles investigated problems of radio communications, radar, and aircraft navigation and control, contributing fundamentally to MIT's prominent role in radar research and development during World War II. It was in this research, over a period of close to fifteen years dating from the mid-1920s, that he built his professional reputation. This research was complemented and reinforced by his effort to establish a curriculum and a base of students through a series of courses on communications engineering in a shadow department called a "communications concentration."[46]

But Bowles and his program fitted uncomfortably into MIT president Karl Compton's aspirations to enhance fundamental research at the university. Bowles's Round Hill program apparently was too narrowly practical under Compton's new criteria, and Bowles himself was only trained through the master's level. His practical orientation and the fact that he did not possess a doctorate weakened his standing as Compton applied more rigorous standards in evaluating university programs and personnel. After Compton's arrival at MIT in 1930, Bowles looked

46. An account of Bowles's prewar activities is Alex Soojung-Kim Pang, "Edward Bowles and Radio Engineering at MIT, 1920-1940," *HSPS* 20 (1990):313-338. On MIT under Compton and with some background on Bowles during this period see Larry Owens, "MIT and the Federal `Angel': Academic R&D and Federal-Private Cooperation Before World War II," *ISIS* 81 (1990):189-213; and Karl L. Wildes and Nilo A. Lindgren *A Century of Electrical Engineering and Computer Science at MIT, 1882-1982* (Cambridge, MA: The MIT Press, 1985), chapters 6 and 12-13. On Bowles's views of MIT and his work see Edward L. Bowles, "There Followed 38 Years of Distinguished Contributions to MIT," *Technology Review* (July 1966).

increasingly to his external sponsors--private philanthropists, corporations, and the Army Air Forces--rather than the university for his professional justification. During this time Bowles established his relationship with Arnold as part of a contract with the Air Corps to study the use of radar navigation methods in poor weather conditions. Also in this period Bowles began to craft his view of the role of an engineering professional, a view in which pedagogy and professional knowledge were rooted in collaboration with industry and government rather than in a tradition of fundamental research.[47] Bowles was an active participant in MIT's Industrial Cooperative program, which provided students and faculty with experience at General Electric, Western Electric, and Bell Telephone Laboratories. He would draw on this experience during and after the war to suggest models for managing research and development and for building cooperative relations between industry and the military.[48]

In the years to follow, Bowles's deflating experiences with Compton would color his approach to postwar planning, shifting his professional loyalties from academia to the Army Air Forces and the aircraft industry. Vannevar Bush, Bowles's MIT colleague and rival, was even more influential in redirecting

47. Bowles turn here was not unprecedented. Bowles's MIT colleague, engineer Stark Draper, also oriented his work toward external sponsors. See Michael A. Dennis, "A Change of State: The Political Cultures of Technical Practice at the MIT Instrumentation Laboratory and the Johns Hopkins University Applied Physics Laboratory, 1930-1945" (Ph.D. diss., Johns Hopkins, 1990).

48. On MIT cooperaton with industry see K. Wildes and N. Lundgren, *A Century of Electrical Engineering and Computer Science at MIT, 1882-1982*, note 46; and Larry Owens, "MIT and the Federal `Angel'," note 46.

Bowles's personal and professional outlook. On coming to MIT in 1920 he studied under Bush, completing a master's thesis under his direction. Sometime during his early career Bowles came to dislike Bush passionately.[49] Bowles never did express clearly the source of his antipathy toward Bush, but, in part, he felt that Bush took credit too readily for the work of others, especially MIT students under his tutelage. Their managerial styles differed too. "Bush wanted tight organization, clear lines of authority, and control, even while stimulating research. Thus individuals tended to be subordinated to the interests of the organization. Bowles, on the other hand, preferred operating in a freewheeling, individualistic way."[50] Drawing on his hunting background as a youth, Bowles would later describe Bush as a "varmint" and a "rascal" whom Bowles needed to track and keep a wary eye on.[51] As Bush's career advanced at MIT and during the war as head of OSRD, Bowles continually saw himself as competing with Bush, especially in articulating prescriptions for the postwar relations among academia, industry, and the military. Bush, for the most part, did not seem to reciprocate these feelings of antagonism.

Ironically, though, Bush was the one to give Bowles the opportunity to recast his career. In 1940, as war tensions mounted, Bush persuaded President Roosevelt

49. Bowles was not the only person rubbed the wrong way by Bush. The most complete account Bush's career and personality is G. Pascal Zachary, *Endless Frontier: Vannevar Bush, Engineer of the American Century* (New York: The Free Press, 1997).

50. In K. Wildes and N. Lundgren, *A Century of Electrical Engineering and Computer Science at MIT, 1882-1982*, note 46, p. 109.

51. Bowles shared these thoughts with numerous researchers who interviewed him, including Daniel Kevles and Michael Sherry, as well as this author. See Edward L. Bowles, Oral History Interview, 1987, RAND History Project, NASM.

to mobilize science in support of military preparations, resulting in the creation of the National Defense Research Committee (NDRC) and, then in 1941, the OSRD. Bowles joined in the effort, helping to organize and then serving as secretary for the NDRC Microwave Committee. In this capacity he played an instrumental role in moving radar from an experimental to a mass produced device and in establishing the MIT Radiation Laboratory. Soon thereafter Bowles was maneuvered out of the Radiation Laboratory as physicists took charge of the enterprise. In 1942 Bush then recommended Bowles to serve as Expert Consultant to Secretary of War Henry Stimson, who was seeking advice on the introduction of the new radar technologies into the Army. Bowles assumed the additional position of Special Consultant to the Commanding General of the Army Air Forces Arnold in 1943 (on Bowles's organizational placement with Stimson and Arnold see Figures 1 and 2).[52] In these capacities in the military, Bowles was the most highly placed civilian concerned with the mobilization and application of science and technology to the war effort. It was from this vantage, with its special institutional interests and opportunities, that Bowles reconstructed his career and expounded his own outlook for postwar organization--often in opposition to Bush.

Bowles worked closely with Stimson and Arnold at the Pentagon, his office near theirs. Under their auspices, Bowles presided over a small institution--a loose organization situated at his Pentagon offices and composed of scientific and technical experts drawn from academia, industry, and sometimes Bush's OSRD. This

52. These charts are from a Bowles biographical file: Folder "War Effort: ELB and Associates, Articles and Writings," Box 4, E.L. Bowles Papers, NASM.

Figure 1: War Department Organization, July 1944

Source: E. L. Bowles Papers.

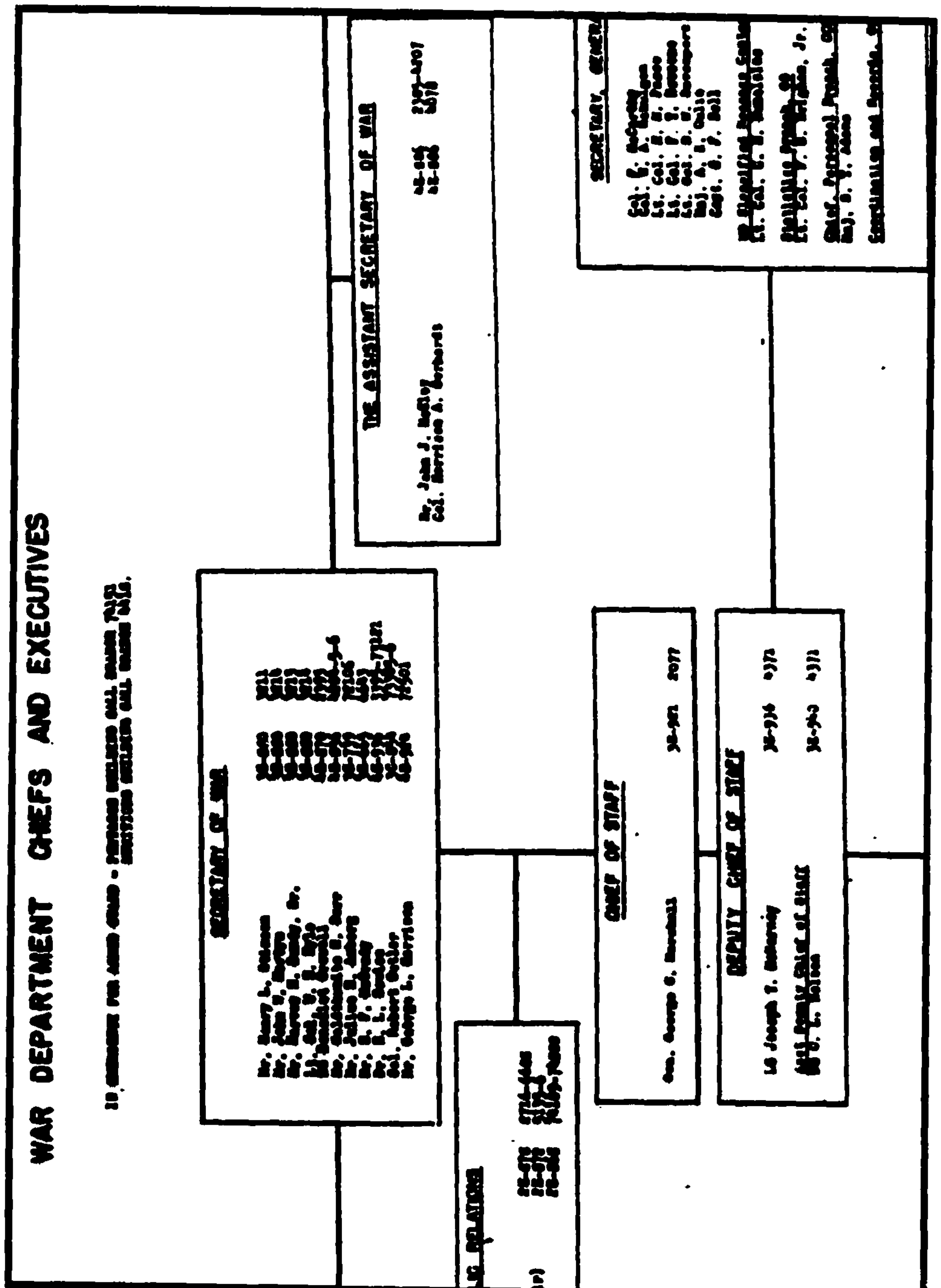
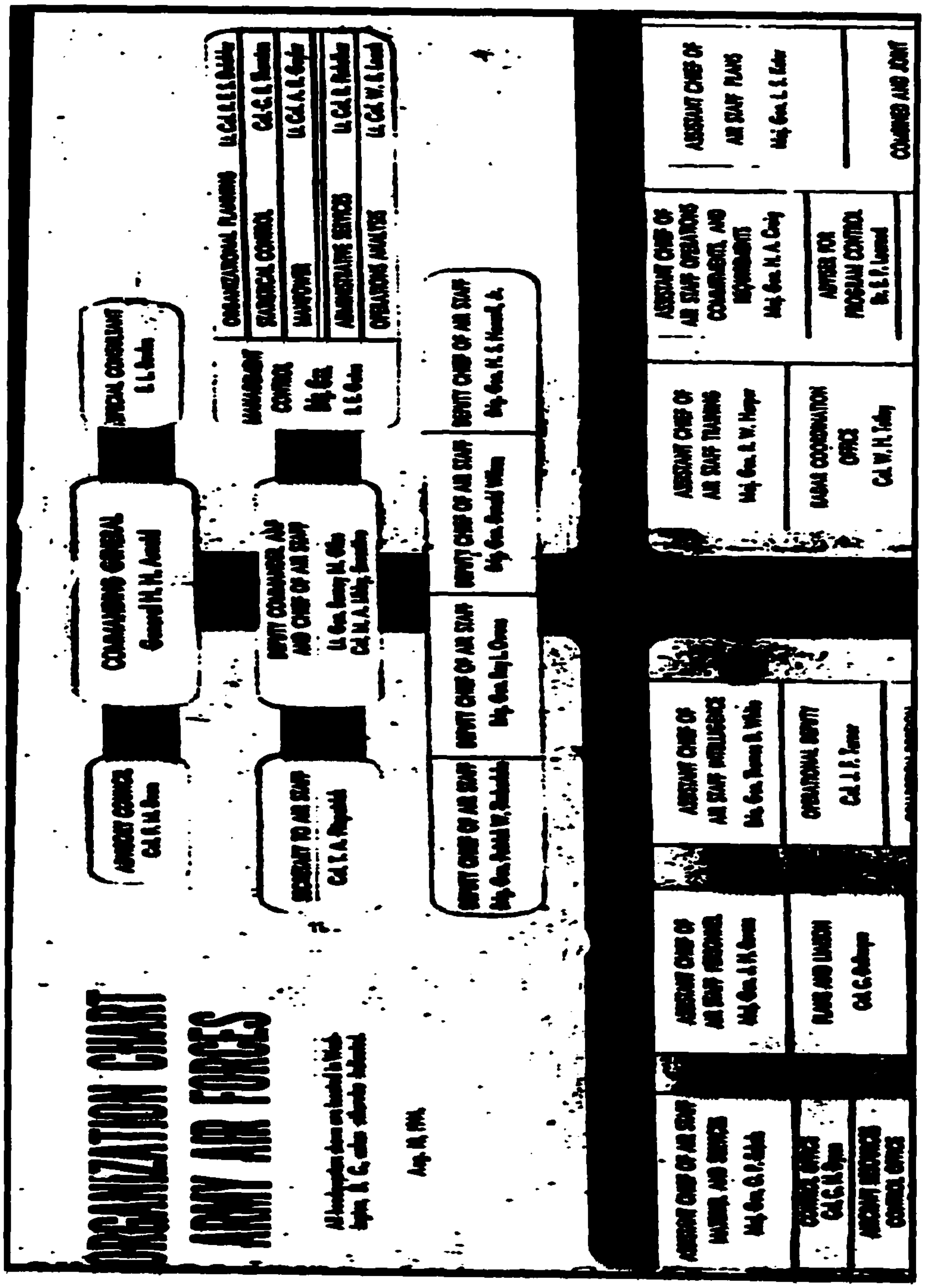


Figure 2: Army Air Forces Organization, August 1944

Source: E. L. Bowles Papers.



wartime office of expert consultants was relatively small, never containing more than about fifty individuals.[53] But it had a leverage beyond its numbers. Bowles and his consultants worked closely with major decision-makers in the civilian and professional military. As proxy for Stimson and Arnold, Bowles was able to assemble a distinguished roster of prominent consultants from academia and industry. These included staff of the MIT Radiation Laboratory such as Lee DuBridge, Louis Ridenour, and David Griggs; established and rising research stars such as, respectively, Irving Langmuir and William Schockley; and top managers and engineers from the aircraft, electronics, and communications industries.[54] But central to Bowles's leverage was a critical function the office performed: the adaptation of laboratory devices to the battlefield, and its opposite, the adaptation of military practices and organization to new devices. Adaptation of new devices, weapons, or military practice was not a foregone conclusion. It required skill, effort, and persuasion. Bowles's primary task, which he largely created for himself, was to define and manage such adaptation.[55]

53. The fullest account of Bowles's wartime work is an unpublished participant's history written by one of Bowles's staff: Allen V. Hazeltine, "A Summary of Activities: Office of Dr. Edward L. Bowles, Expert Consultant to the Secretary of War and Special Consultant to the Commanding General Army Air Forces, " (November 1945), Box 8, E.L. Bowles Papers, NASM. Parts of his actvities as a consultant during the war in the War Department and Army Air Forces are sketched in Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (New York: Knopf, 1979):309-312, and in Sherry, *The Rise of American Airpower*, note 14, pp. 195-199;230-233.

54. On Bowles's roster of consultants see Hazeltine, "Summary of Activities," note 53. Bowles selected and deployed consultants with multiple purposes in mind. Problem solving was paramount. But Bowles saw this activity as fertile ground for promoting new institutional relationships and, particularly, for demonstrating to military leadership that active management of technological resources paid dividends.

55. Bowles's was not alone in this type of work. OSRD through its Office of Field Services and through various operations research activities was also active in this area. For a description of OSRD work in these areas see James P. Baxter,

Bowles and his staff were active in a number of key episodes in which the problems of technical and institutional adaptation were central. These ranged from well-publicized events of the war, such as the campaign against German submarine attacks on Allied ships and the defense of Great Britain against German V-1 weapons, to less dramatic internal concerns such as the reorganization of the Army Signal Corps in summer 1944 to shift responsibility to the Army Air Forces for research, development, and procurement of radars and communication devices.[56] Bowles negotiated this reorganization to enhance Army Air Forces control over technologies that were increasingly integral to service performance in the combat theaters. Bowles persuaded Commanding General of the Army George C. Marshall to take this step and redefine radar and related equipment as "a part of the main problem of aircraft design and operation rather than accessories."[57] Bowles had negotiated an important redefinition of what was to count as an aircraft, and, in the process, had recast institutional responsibilities and roles. An apparently discrete question on the procurement of new technologies was used to construct a

Scientists Against Time (Boston: Little, Brown, and Co., 1946):404-418.

56. These and other examples are contained in Hazeltine, "Summary of Activites, note 53. Bowles was a profilic memo writer to Stimson and Arnold during the war, summarizing his work and its implications. Typical of this is Bowles, "Resume of Consultant Activity," Memorandum for the Secretary of War, 23 August 1943, Folder "War Effort: ELB and Associates--Articles, Resumes, ...", Bowles Papers, Box 4, NASM. Bowles's role in the submarine campaign is partially described in Elting E. Morison, *Turmoil and Tradition: A Study of the Life and Times of Henry L. Stimson* (Boston: Houghton Mifflin Co., 1960):563-580.

57. Memo from George C. Marshall to General Arnold, 26 July 1944, File "Scientific and Technological Resources as Military Assets," Box 2, E.L. Bowles Papers, NASM.

new definition of the airplane and to reconstitute a significant institutional boundary between the Army and Army Air Forces.

From 1943 until the end of the war, though, Bowles's most significant strategy for adapting technologies and institutions was the creation of "Advisory Specialist Groups." These groups were composed of consultants from his office and were sent to operational theaters in Europe, the Mediterranean, the Pacific, and to commands in the United States. Most frequently, the Advisory Specialist Groups tackled the problems encountered in moving the still new devices of airborne and ground radar and radio navigational aids from the laboratory setting to the demands of use in the battlefield. Problems ranged from specific issues such as geographical siting and relative placement of radars, to broader questions about training and redefining organizational responsibilities for operating the new equipment and for reworking tactical practices. In summer 1944, for example, Bowles dispatched Louis Ridenour, a noted physicist from the University of Pennsylvania, to adapt air defense radars (MEWs) to coordinate and control offensive air attacks against Germany. The MEWs had the capacity to track a large number of planes compared to radars which had been used to assist with offensive campaigns. Ridenour readily worked out this new application, enhancing the effectiveness of the air attack.[58]

Bowles's consultants worked directly with theater combat commanders during their overseas missions. This innovation gave the combat commanders direct

58. See Hazeltine, "Summary of Activities," note 53.

access to experts able to evaluate and apply the new devices to the battlefield. In composing these advisory groups Bowles made a point of selecting both academic and industry representatives as a way to ensure that technical, operational, and organizational issues would each receive attention. Attaching these groups to commanding generals and involving them in the day-to-day business of fighting the war served an important end. Their successes, which were many, were immediate, visible, and concentrated in the place most crucial to the military, the battlefield.[59]

Bowles's goal was also to create a place in which service and industrial interests could intersect. As an example, in the spring of 1944 Bowles proposed to Oliver Buckley, president of Bell Telephone Laboratories, one of the principal firms conducting research and development on service radar and communications equipment, that Buckley send one of his top engineers to the European and Mediterranean theaters. This would be an opportunity, Bowles offered, to see first hand the performance of equipment under field conditions and assist the military in using the equipment more effectively. In a summary of this activity to Arnold, Bowles identified this as a method by which "topside thinking in industrial laboratories could be more closely allied with combat requirements."[60] Bowles also extended these opportunities to the Radio Corporation of America (RCA) and other companies.[61] The battlefield was an extension of the corporate laboratory's

59. On the contributions of advisory specialists see Hazeltine, "Summary of Activities," note 53.

60. Memo from Special Consultant to the Commanding General, AAF, Dr. Edward L. Bowles to H. Arnold, "Summary of Activities," p. 2, 3 August 1945, folder "Chron File, 2 May 1945-13 Aug 1947," Box 8, Bowles Papers, NASM.

61. Ibid.

own regimen of testing, evaluation, and product development. Through the use of his Advisory Specialist Groups and the openings they created for linking service and corporate interests, Bowles both contributed to success in the battlefield and demonstrated to military and industry leaders the practical value of his ideas for connecting the military with industry and academia.

Bowles's work in this regard partly overlapped with activities of the OSRD, particularly the Office of Field Services, and with the various operations research activities of the agency. In fact, many of Bowles's consultant specialists were on loan from their OSRD assignments, particularly from the MIT Radiation Laboratory. The OSRD efforts had the same purpose as Bowles's undertakings: adapting new devices to the battlefield. This overlap in effort reflected a measure of caution in the military relationship with OSRD engendered by differences in values and goals.[62] Bowles's efforts represented a determination on the part of Arnold and other professional military not to be dependent on scientists and scientific institutions beyond their control. Arnold, in particular, stressed the importance of developing an indigenous ability to handle the service's technical needs.[63] Bowles's office and his Special Advisory Groups contributed to this end in several crucial ways: as an internal resource that the military leadership could

62. On the OSRD's work in this area see Irvin Stewart, *Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development* (Boston: Little, Brown, and Co., 1948).

63. The most visible expression of this concern near the end of the war was Arnold's establishment of the Scientific Advisory Group, headed by aerodynamicist Theodore von Karman. See Sturm, *The USAF Scientific Advisory Board*, note 1.

draw on instead of OSRD; as an independent check on Army and Army Air Forces interactions with OSRD; and as a conduit from military leadership to OSRD. Bowles's role, which he relished and cultivated, was to be part of military staff, directly representing military interests.

Another tool Bowles used for working through questions of technology, institutions, and adaptation and for promoting his concepts of integrating industry and academia into the military was "special projects." One of the most important of these was an undertaking called the Special Bombardment Project inaugurated in summer 1944 to examine how the B-29 might be more effectively applied to the air war in the Pacific.[64] As with Advisory Specialist Groups, Bowles's strategy was to bring together industry representatives and military officers. With Arnold's blessing Bowles organized a group composed of Arthur Raymond, chief engineer at Douglas Aircraft; Raymond's assistant Frank Collbohm; Edward Wells, chief engineer of Boeing Aircraft; and several officers from Air Staff planning offices. Raymond and Collbohm formed the nucleus of the project at Douglas, but worked under the auspices of Arnold and Bowles. Bowles's purpose in the Special Bombardment Project was to establish a particular precedent: to join industry expertise to the highest level of military combat planning. Military officers would share with the industry members "specific targets to be destroyed, the order in which they were to be eliminated, and information on existing and potential future bases from which operations might be carried out, together with necessary technical and

64. The most complete documentation of this project is in Folder "War Effort--Special AAF Projects ... Special Bombardment Project," Box 3, E.L. Bowles Papers, NASM.

military data needed for planning."[65] The industry team would then apply its expertise to analyzing the B-29 and its capabilities to meet a specific military objective of 1944-1945: the bombing of mainland Japan.

The results were seemingly successful, but too late in the war effort to make a substantial contribution. Raymond, Collbohm, and Wells focused on weight reduction to improve performance of the B-29s. By stripping armor plating for defense, the weight of the planes was substantially reduced, increasing the bomb load from 6,000 to 20,000 pounds and increasing the B-29's top speed. This, in turn, reduced defensive requirements to one rear gun.[66] In addition, the industry team adapted a higher performance bombing radar to the planes, reportedly equaling and exceeding the precision of visual methods. Like Bowles's other consultants, Collbohm, as a representative of the industry team, traveled into the theater to participate in the application of the innovations. Through the analysis and efforts of the industry team, Arnold commissioned in May 1945 a wing of specially fashioned B-29s, the 315th Bombardment Wing of General Curtis LeMay's XXI Bomber Command. New crew training further delayed use of the retooled aircraft. In fact, this special project provided the organizing ideas and personal relationships which would be the start of Project RAND just over a year later.

65. Hazeltine, "A Summary of the Activities," note 53, p. 116.

66. Before Bowles organized this project a Wright Field study group was also examining ways to reduce the B-29's weight. Raymond, Wells, and Collbohm drew extensively on this work. In their final report to Bowles, which summarizes much of the Wright Field analysis, it is difficult to tell if the industry team added anything signficant to this parallel study. The report is attached to Memorandum E. Bowles to Giles, 11 October 1944, Folder "War Effort--Special AAF Projects ... Special Bombardment Project," Box 3, E.L. Bowles Papers, NASM.

Bowles used his Special Advisory Groups and special projects as vehicles to establish patterns and precedents for industry interactions with the military. He sought to legitimize the use of industry as more than a producer of commodities. Industry, he felt, should be a resource for the military, providing personnel, technical, and managerial expertise, and even complete services such as long-distance communications, which had traditionally been an internal responsibility of the services. Industry could even be a planning and operational adjunct of the military. Bowles's deployment of specialists into the battlefield and into the sanctum of planning blurred the traditional boundaries between industry and the military. The battlefield and the planning room could be places of military action or decisions and of industry efforts to extend the work of laboratories and marketeers. Bowles believed that each party could come to view its work as a functional contribution to a common end: national security. Each could share its particular strengths: The military's experience in the battlefield and in planning, and industry's technical expertise and, especially, its experience in the management of technological innovation in the context of large organizations and markets. And in each case--whether radar or B-29s--specific technologies provided the entree for reworking social relations and the meaning of the technologies themselves.

While Bowles was sending his consultants into the field, he was also busy making these arguments to civilian and military leadership and outlining their implications for institutional changes. Typical was a 1943 memo to Stimson in which Bowles laid out his thoughts:

> It is clear that those in top level administration and planning authority must think of communications and radar not in terms of highly technical devices or commodities, but in operational terms of what can be accomplished with them. There is too great a tendency to leave the destiny of communications and radar to technical officers who themselves are totally unfamiliar with strategic thinking and usually too engrossed in the physical devices themselves. I am [now] exploring the possibilities of generating literature which will treat communications and radar in functional terms and in a manner useful to those at staff and planning levels.[67]

This was part of Bowles's efforts to demonstrate to Stimson and Arnold that the new devices could provide openings to organizational reform. The success of radar, communications, and other technologies in the battlefield had become a socially agreed upon fact of the war. Bowles saw this fact as fragile. It depended on a carefully crafted set of relations running from civilian and military laboratories to industry, to service procurement offices, to personnel, training, and operations practices; to use in the battlefield; to strategic doctrine; and, especially, to the military leadership in the battlefield and on the general staff. All of these needed to be properly coordinated and managed in order to sustain success in the battlefield.[68]

This was what Bowles meant in examining the implications of technology for the military in "functional terms." Behind this bland managerial phrase lay a far-reaching implication. Military leadership had the opportunity and, in Bowles's

67. E.L. Bowles, "Résumé of Consultant Activity," Memorandum for the Secretary of War, 23 August 1943, p. 13, Folder "War Effort: ELB and Associates--Articles, Résumés, ...", Box 4, E.L. Bowles Papers, NASM.

68. In many ways this was analogous to the problems of making a product successful in the commercial marketplace. As a professor at MIT in the prewar period, Bowles was very familiar with the difficulties of moving the products of the laboratory through industry to the marketplace.

view, the responsibility to reconceive their own organizations. The procurement and deployment of the new, successful weapons of the battlefield now constituted the rationale around which the military should organize. Internal organization and external relations should be analyzed, broken down, and reconstituted to reflect the centrality of technology to military mission.

It is worth noting technology's status as an agent of social change. Technology did not determine military choices and organization. Rather, in Bowles's analysis, it was an instrument for organizing resources that then could be directed toward institutional ends. War Department and military leadership only needed to exercise their political, fiscal, and managerial authority to make choices that would define and secure the set of relations in which the new devices would take their place.[69] Hence, the goal of reform, for Bowles, was to acknowledge not just rhetorically but *institutionally* that the new devices of war were instruments for opening up established institutional boundaries, redeploying resources, and establishing new relationships. Institutional reform would make this insight concrete,

69. Bowles's stance is noteworthy in the context of the rhetoric of technology and national security in the postwar period. There was an ambiguity in the postwar military's presentation of the processes of technological change. On the one hand innovation needed to be purposively stimulated, controlled, directed. Appropriate mechanisms were required both to insure a vital pace of innovations and to coordinate innovation and military interests. On the other hand, within the Air Force and other services, innovation was often portrayed as inevitable and autonomous--with respect to both developments by the Soviet Union and American industry and universities. These characterizations were not incompatible. The autonomous dynamic of innovation also needed to be guided and channeled to military interests. In either case, these characterizations of innovation served several purposes. Foremost, they justified a response to the USSR in which *technology* was central, as well as large appropriations to support industry and universities. For Arnold's use of the rhetoric of technology see speeches cited earlier.

consolidating the control of military leadership over the development, production, use, and social meaning of weapons and devices.

The possibility of internal reform was only part of the message. In rejecting the notion that the new devices were commodities, Bowles directed Stimson's and Arnold's attention to the circumstances of their production. Procurement was not a passive but an active function. Relations with industry and university laboratories could be managed to meet military interests. In the same 1943 memorandum to Stimson, Bowles outlined this point of view:

> ...to insure the success of our radar program, I am endeavoring to tie into our Air, Ground and Service Forces for assistance by consultation a well-balanced group representing both the scientist and engineering planners with an understanding of design and manufacture. The plan will, I am sure, expedite our radar program by providing the sort of top-level coordination which can be effected through your office. I cannot over-emphasize the need for such a stabilizing influence which, in effect, brings together the Army, the scientists, and the industry on neutral ground.
>
> But this is only one side of the problem. Not only is it important to bring civilian specialists into the Army to help but equally vital to see that the Army sends qualified talent into outside laboratories. There is no better way I know to control research and development which may run rampant.[70]

As Bowles's consultant efforts turned increasingly to the problems of the Army Air Forces, his concerns extended beyond radar and communications to aircraft and guided missiles. This provided a broader base for his planning activities and additional opportunities to solidify his role as an authoritative voice on the role of technology in the military.

Bowles was highly successful in his war work, especially in the area that counted the most: contributions to victory in air campaigns in Europe and in the

70. Bowles, "Résumé of Activity," note 67, pp. 14-15.

Pacific through his consultants working in the field. He had won the confidence of Stimson, Arnold, George Marshall, and other leaders. But the end of the war in 1945 found Bowles in a difficult professional position. None of his primary institutional reference points, MIT, the War Department, and the Army Air Forces, promised secure bases from which to further his career. Before the war his relations with the MIT management, especially Karl Compton and Vannevar Bush, had become increasingly strained. Returning to MIT was not a palatable option. His estrangement from MIT and his strong ambivalence toward his former colleagues, especially Bush, had a powerful effect on Bowles. He saw Bush as a competitor in postwar planning, someone against whom his own work was defined and measured.[71] Bowles explicitly sought to construct a professional and ideological role for himself apart from--and in many ways counter to--Bush and MIT.

With his opportunities uncertain and negative feelings toward Bush, Bowles made a crucial and unusual choice for academics who served in the war: he cast his professional lot with the War Department and the Army Air Forces. This choice presented some difficulties. By definition his position as a consultant at the War Department was tenuous: He had been hired as staff for an important but ad hoc position. In his military capacities Bowles had considerable influence and leverage as the resident scientific and technical authority. He had been given considerable authority to act for Stimson and Arnold in selected but key areas, such as com-

71. By the end of the war Bowles's odd mixture of paranoia, antipathy, and respect toward Bush seemed to border on the pathological. Their relationship will be discussed in more detail in Chapter 3. See also Bowles, "Office Diary, 1947-1948," Box 8, ELB Papers, NASM, as a gauge of his obsession with Bush in the postwar period.

munication and research organization. But both would soon retire, and other staunch allies, such as General George Marshall were moving on to new responsibilities. In short, Bowles's position as a consultant depended primarily on the support and authority of others. With his consultant corps disbanding at the end of the war, he had no institutional base of his own. Moreover, by serving both the War Department and Army Air Forces, he had located himself at a divisive institutional fault line. He had managed this well during the war, but at war's end the Army Air Forces's concerted push for independent status made it more difficult for him to satisfy his different sponsors.

Despite these limitations, which were apparent to him, in 1945 Bowles thought the military offered him the most promising professional opportunity. The demands of war had not allowed him the chance to formulate a clear program of reorganization and reform. This was the broad task that Bowles set himself in the waning months of hostilities.[72]

Bowles, of course, was not alone in the perception that the end of the war was a defining moment for military reform and relations with universities and industry. Vannevar Bush and a constellation of university administrators and professionals and industrialists saw this as a critical opportunity for allying the military and the private sector. But his voice in these matters is noteworthy for two reasons. First, he still held a position of influence through which he could

72. Bowles's notion of "integration for national security," cited earlier, presented in a March 1945 speech was one step. See note 45.

make his views manifest. As proxy for Stimson and Arnold, Bowles occupied a position of influence second only to Bush on matters pertaining to military and science. Even with modest resources, he was in a position to change institutions and policy, as well as promulgate an ideology and point of view. Second, and perhaps most important, he made military interests the preeminent consideration in his postwar planning. In this he clearly differed from Bush and other academic planners. He did not attempt to prescribe a balanced system that assured the vitality and integrity of traditional elements of the American polity, as Bush did in his influential *Science--The Endless Frontier*.[73] Bowles rather sought to submerge the different cultural communities contained in this polity in support of a preeminent goal: War Department and Army Air Forces postwar interests. These interests were not, of course, monolithic. Bowles gave his greatest attention to the interests of the top professional military: Henry Arnold and Dwight Eisenhower. Within this framework he tried to help give definition to those interests and offer means to achieve them.

By the conclusion of the war in August 1945, Arnold and Bowles had developed a close working relationship. They shared an ideology centered on preparedness and a concept of relations with industry and academia in which mili-

73. For an indication of the political context of postwar planning see Daniel J. Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944-1946," note 28. On Bush and postwar planning see Daniel J. Kevles, "The Debate Over Postwar Research Policy, 1942-1945: A Political Interpretation of *Science--The Endless Frontier*," *Isis* 68 (1977):5-26; and Nathan Reingold, "Vannevar Bush's New Deal for Research: or the Triumph of the Old Order," *HSPS* 17 (1987):299-344. See also Bush's own views in Vannevar Bush, *Modern Arms and Free Men* (New York: Simon and Schuster, 1949).

tary interests would be primary. They also shared a sense of urgency to make concrete the insights of their war experience. Bowles needed to secure a place for his professional skills. Arnold was planning to retire in February 1946 after his long and distinguished career and the trauma of previous heart attacks. Both had already implemented internal reforms to refashion the relations between the service and technology. Arnold took steps toward that shaping as early as 1943, when he established two postwar planning groups, the Post War Division and the Special Projects Office.[74] These were to examine two parts of his air power prescription: defining the scope and composition of an "air force-in-being" and to outline requirements for overseas bases. In late 1944 Arnold inaugurated the most well-known of his initiatives to connect science with the service: establishing SAG under Theodore von Karman's leadership.[75] But these were just steps along the way. All were oriented toward planning and the exploration of possibilities. Even von Karman's effort to connect the service with sources of research was only a partial realization of the goals Bowles and Arnold sought to achieve. The SAG was a part-time consultant group; more important would be incorporating skills and articulating institutional arrangements which were part of the daily life of the service.

74. The establishment of the Post War Division and the Special Projects Office were in response to postwar planning initiated in the War Department and to discussions in Congress. On this see Wolk, note 1, chapter 2.

75. Memo from H. Arnold to T. von Karman, 7 November 1944, Series: Official Files, 1932-1946, folder "AAF Scientific Advisory Group," Box 40, H.A. Arnold Papers, Library of Congress. This memo identified many of the same themes emphasizing the future role of science and technology in service life Arnold articulated in his January 1945 address to air staff officers.

One of the first moves in this direction followed Arnold's January 1945 talk to Air Staff officers described at the beginning of this chapter. It was a prelude to official actions taken later that month to reorganize the Army Air Forces headquarters. Three principles guided this reorganization, echoing the themes of his talk: decentralizing operational decisions to commands, focusing planning and policy in the air staff, and creating for nonrated officers (those other than pilots) career opportunities previously unavailable to them. This last principle was explicitly to encourage the incorporation of scientists and engineers into positions of responsibility. The assistant chiefs of staff below Arnold and the heads of commands were to apply these principles as they implemented the specifics of the reorganization. Arnold's guiding principles seem on the surface to be pragmatic, unremarkable responses to the changed conditions brought about by the nearing end of the war. Yet the institutional consequences of his ideology of preparedness are clearly visible.

In broad thrust Arnold sought to create a service that had the managerial strengths associated with business practice and that strengthened ties to inputs of science and technology. Together these organizational changes were an attempt to strengthen the control of military leadership over policies and decisions that were critical to the political and functional life of the institution. Arnold's reorganization was a first step to refashion the Air Force for a postwar world. Pilots, at least on paper, would have to begin to adapt, sharing prestige, authority, and control of the organization with officers and other professionals (particularly the "long hairs") for whom science and technology were the defining tools of the postwar service.

Chapter II

"Two Assignments Inextricably Related": The RAND Contract and Adapting the Military for Science and Technology

At the end of the war Arnold and Bowles embarked on two interconnected institutional changes to recast the Army Air Forces's management of science and technology. One was to create a position, the Deputy Chief of Staff for Research and Development (DCS/R&D), for decision-making on science and technology at the top of the Air Staff. This was the third ranking position in the Army Air Forces management hierarchy; Curtis LeMay, a wartime hero of the strategic bombing campaigns, took on the new post in December 1945. The second was to initiate a series of discussions with Douglas Aircraft Company to form a new organization for linking service and industry leadership. These discussions would lead to the establishment of Project RAND in March 1946. The first effort was directed primarily at reforming the Army Air Forces's internal decision-making on science and technology; the second was to forge a new means for coordinating the development of weapons with the aircraft industry. This chapter explores Arnold's and Bowles's pursuit of these complementary objectives and their significance in the two men's attempt to make concrete their visions of postwar organization. The chapter also examines Bowles's implementation of similar reforms in the Army. His signature achievement was a policy paper, "Scientific and Technological

Resources as Military Assets," promulgated under Army Chief of Staff Dwight Eisenhower's signature. For Arnold, who retired in February 1946, and Bowles these several undertakings were the necessary first steps in remaking the Army Air Forces for modern war.

First Steps: RAND and the Deputy Chief Of Staff, Research and Development

In September 1945, with the war concluded, questions of science and technology in service life were central for Arnold and Bowles. Their deliberations revolved around two technologies: the atomic bomb and the long-distance missile. Their concerns were not only with research or procurement but with the implications of these weapons for the service's basic doctrine--strategic bombing--and for management and organization. This concern was, in part, a reflection of Arnold's commitment to evaluate the meaning of new technologies for the service's future. At that point, the Army's Manhattan Engineer District, outside service control, directed research, development, and production of the atomic bomb. And long-distance missiles were a technology still to come, with the German V-2 a suggestion of the weapon's possibilities. But each represented a dramatic reconceptualization of the conduct of warfare. For Arnold the missile embodied greater potentialities for change, affecting the concept of strategic bombing, the pilot-airplane culture of the service, and a remaking of relations with industry and academia. In their promise as revolutionary weapons, these new technologies seemed to present an imperative derived from Arnold's and Bowles's war experience: the new weapons presented an opening to refashion relations within and external to the service.

Arnold delegated the question of the impact of the atomic bomb on strategy, organization, and force structure to three respected generals of the war: Carl Spaatz, Hoyt Vandenberg, and Lauris Norstad. They would return with a report in late October 1945, concluding that the bomb required no change in the organizing ideas and operations of the service.[1] But Bowles and Arnold chose to examine the implications of missiles themselves. To start, they drew on their wartime connections, many of which converged on the service's relations with Douglas Aircraft Company. As with the B-29 Special Bombardment Project during the war, considerations regarding long-distance missiles would require close collaboration between top military planners and industry experts. Through the B-29 project Bowles had already established such a relationship with Douglas's chief engineer, Arthur Raymond, and with Frank Collbohm. In addition, during 1944 Bowles had also tasked Collbohm to do a complete review of Army and Army Air Forces missile programs, instigated by a request from President Roosevelt on the impacts of the German V-1 and V-2 weapons. Collbohm continued to have responsibility for this issue through the end of the war.[2] Arnold, too, worked closely with the com-

1. On this see Herman S. Wolk, *Planning and Organizing the Postwar Air Force, 1943-1947,* (Washington, D.C.: Office of Air Force History, 1984): 121

2. Memor from E. Bowles to F. Collbohm, 8 March 1945, Folder "WE=RAND Corr. thru 6/53 with F. Collbohm," Box 1, E. Bowles Papers, NASM. Bowles even pushed Collbohm to consider the use of missiles against Japan as part of the B-29 project. Arnold, Bowles argued, had given them "a grand opportunity to show what a strong civilian body can do. We must not fail to demonstrate in this instance that we can do it; otherwise it will be cited as just another illustration of how civilians fail the Army in the long run." It is not clear to what missiles or program Bowles might have been referring to. The state-of-the-art in the U.S. at that time would not have compared to the destructive power of a B-29.

pany in the spring and summer of 1945. Donald Douglas, president of the company, conferred with Arnold frequently on broad questions of national air policy and the relations to be encouraged among industry, civil aviation, and the military.[3]

On October 1 Arnold, Bowles, Douglas, Raymond, and Collbohm met at Hamilton Field near Los Angeles to discuss the possibilities for developing a long-distance missile. Bowles summarized the meeting in a letter to Robert Patterson, Stimson's successor as Secretary of War.[4] The meeting was "to assist in the consolidation of ideas which F.R. Collbohm and I discussed with you on Wednesday, a week ago. These ideas had to do with a long-range program--long in time and distance---directed toward the achievement of an intercontinental guided missile."[5] At the meeting at Hamilton Field, Arnold charged Bowles to "get the job under way...and to give it special administration." Funding for the project, $10 million, would come from the budget of Wright Field (the Army Air Forces technical entity responsible for research, development, and procurement) budget, but would be administered through the Assistant Chief, Air Staff, in charge of plans.

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3. See Chapter I, note 42.

4. Patterson had been Under Secretary of War under Stimson. With Stimson's retirement Bowles arranged to continue his status as Expert Consultant, maintaining the same relationship with Patterson as with Stimson during the war. See E. Bowles letter to Patterson, 25 September 1945, Folder "Chron File 2 May 1945-13 Aug 1947," Box 8, E. Bowles Papers, NASM. With the advent of the atomic bomb, Bowles also sought to perform assistance, left unspecified, on atomic energy issues.

5. Letter E. Bowles to Patterson, 4 October 1945, p. 1, Folder "Background Data and Corr. on RAND ...," Box 1, E. Bowles Papers, NASM.

The Douglas staff was eager to move ahead, offering to "attack the whole broad problem of developing an intercontinental guided missile...including atomic warhead and atomic propulsion." Sponsorship, they thought, might need to include the Army's Manhattan Engineer District. But Douglas offered to move forward without this support as a "stepping stone to the larger project." Raymond envisioned the project as a series of straightforward engineering steps:

> Refinement of the type specification working directly with Air Forces Plans as to strategic employment and with technicians as to feasible attainment.
>
> Design studies and evaluation, mockups, reports, and auxiliary tests and establishment of detail specification.
>
> The final phase would be negotiated after the first phase is completed [the above two steps] and would end in the development of a physical article [i.e., a missile].[6]

Arnold and Bowles concurred in the Douglas proposal, envisioning a project of engineering research and study leading to the development and test of a weapon.

But Raymond's outline reflected only part of the missile's import. Bowles explained to Patterson that managing and directing research within and external to the service was "something transcending in scope the consideration of equipment or materiel alone. The proposal of a project on an intercontinental missile emphasizes this point. General Arnold has requested me to recommend to him the

6. A.E. Raymond, Notes for conference with Gen. Arnold at Hamilton Field, 1 October 1945, attached to letter from Bowles to Patterson, 4 October 1945, note 5.

policy and organizational changes necessary to establish research effort in the Air Forces....I consider it inseparably related to the missile program."[7]

In Arnold's and Bowles's vision the missile embodied a network of technical and social relations. One part was to create concurrently structures for researching and developing the weapon and for managing its place in the service. Another was to integrate Douglas's technical know-how with the technical base of the service and with its top management--Arnold and the Air Staff. The contract with Douglas must be so arranged "as to make it reasonable for a commercial organization to operate on a project of this magnitude and general character." But Bowles also foresaw that a collaboration between the Army Air Forces and Douglas on such a crucial weapon would need to be connected to the larger military and policy apparatus--to the Navy, the Research Board for National Security (RBNS), the Manhattan Engineer District, and "whatever body Congress may set up for general research."[8] During the war Bowles had argued that radar should not be conceived of as a commodity. The missile was the same. In the scale of research effort and resources required to produce it and in the implications of its use, the missile was a special example of the ways in which technologies and institutions could be defined together for specific ends--if service management would take the initiative. This was the import of Bowles's letter to Patterson.

7. Bowles to Patterson, 4 October 1945, note 5, p. 2.

8. Ibid.

October 1945 was a busy time for considering these issues. Bowles reported to Arnold on the 24th that he was working on the Douglas proposal and the question of service management of research, "two assignments inextricably related."[9] To connect atomic weapons with the missile question, Bowles began working with Gen. Carl Spaatz, whom Arnold earlier had asked to look at the implications of the new bombs for service doctrine and organization. Together they began to frame a recommendation to Arnold to create a DCS/R&D, a position that would be the Air Staff's third in command, ranking above the series of Assistant Chiefs who had defined the layer of management under the Chief of Staff since a reorganization in September 1945. This deputy would administer the missile project and other research and planning endeavors, ensuring top-level managerial control and direction. Bowles and Spaatz would continue to address the details of this proposal through November.

But in October questions regarding the relations among service interests, management, and research arose in another context. One Bowles had alluded to in his early October letter to Patterson: Congressional hearings called by Senators Kilgore and Magnuson on legislation for the proposed National Research Foundation (NRF). Bowles, Patterson, and Arnold all testified during the month. All followed the War Department's official position, favoring the Magnuson-Bush legislation--lauding it for fostering a national research capability but cautioning that

9. Memo from E. Bowles to Gen. Arnold, 24 October 1945, Folder "WE=RAND--Corr. with Gen. H.H. Arnold," Box 1, E.L. Bowles Papers, NASM.

the bill did not offer sufficient military representation and control.[10] For Arnold and Bowles it was a display of quiet support. They saw the legislation as ancillary to their own efforts to secure for the Army Air Forces its own research sources, directed toward its own needs. The absence of a strong laboratory system within the service made more urgent the interest in establishing close relations with industry and universities. This point of view extended back at least to Arnold's request to von Karman in November 1944 to form the Scientific Advisory Group (SAG). Arnold's move was a direct response to Vannevar Bush's arrangement with President Roosevelt to produce recommendations on the postwar organization of science, initiated early in the fall of 1944. Von Karman's report was to stand as a statement of Army Air Forces interests, deflecting or enhancing whatever recommendations Bush might make later in 1945.[11] Arnold was determined not to rely on institutions controlled or directed by civilian scientists.

Bowles more openly probed this point in what appears to be an early draft of his testimony.[12] He began with a recapitulation of the ideology of preparedness,

10. The standard account is Daniel Kevles, "The Debate Over Postwar Research Policy, 1942-1945: A Political Interpretation of *Science--The Endless Frontier*," *Isis* 68 (1977):5-26. But see also Daniel Lee Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, NC: Duke University Press, 1995). For a military critique of *Science: The Endless Frontier* and of the Bush supported legislation in summer 1945 see Memo from Col. Mills to Dr. Bowles, 21 July 1945, Folder "War Effort--Post War Plans," Box 3, E. Bowles Papers, NASM.

11. On this point see Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944-1964* (Washington, D.C.: GPO, 1967): 8.

12. Preliminary Draft, 12 October 1945, Folder "War Effort--Post War Plans," Box 3, E. Bowles Papers, NASM. This draft does not name the author but is contained in a folder that only holds drafts of testimony clearly identified as Bowles's.

but framed it not in terms of a distant, hypothetical threat to the U.S. but one that was immediate. It was the technologies of air warfare that created this urgency. "...Future war in its most devastating and total phase renders obsolete the majority of mechanisms and devices of warfare used in this conflict....The formation of a powerful striking force and the perfection of defense against such an attack present a problem of the first magnitude."[13] This urgency, he argued, should be the basis for a greatly enhanced military profile in research and development. Congress should establish a research organization directly under the President and managed by the Secretaries of War, Navy, State, and a Director of Military Research and Development. This organization would be dedicated to military problems. "The Congress," Bowles continued, "to meet the immediate national need, faces the problem of setting up in time of peace a project of a greater order of magnitude than that of the Manhattan District. In the broad essentials much of the work will have to be secret, denying complete reports even to the Congress itself....A blank check seems to be required."[14] In composing this draft, Bowles was not reticent about promoting the importance of military needs in the priorities of national life. As in the proposed NRF, scientists and engineers would be thoroughly integrated into the new institution through a series of advisory and working committees. Bowles did not specify how this new institution might relate to the NRF but only that this "proposal should not modify your deliberations or in any sense detract from the bold action you are now contemplating."[15] Somewhere along the way

13. Ibid., p. 3

14. Ibid., p. 7.

15. Ibid., p. 4.

this ambitious proposal was tucked into a file and not used--probably because it departed markedly from the War Department official position of support for Bush's proposal. But it highlighted the deeply-held belief of Bowles and Arnold in the need for politically-supported arrangements for research under military control in the postwar period.[16]

But proposals calling for new national institutions, large costs, and political decisions by Congress and the President were not the paths of least resistance to achieve these ends. A more accessible strategy was to use quietly the internal resources of the Army Air Forces and of established networks of relations with industry to build structures for research and its management. This Arnold and Bowles had already begun. Behind their thinking, especially for Bowles, were models of business research and development organization. These were rooted in Bowles's experience at MIT in the 1920s and 1930s and informed his wartime practices of drawing industry into his advisory apparatus. The value of business models for Bowles was primarily to enhance top management insight into and con-

16. In fall 1945 Bowles expressed similarly strong views in other forums. In a discussion with other academics on the organization of military-sponsored research, he offered (echoing his "integration for national security" speech of March 1945) that: "Hereafter war means the complete regimentation of all our resources. Not only the Air Forces, but the Army as a whole must be conditioned all the way down through the various echelons to carry out scientific directives." See statement from E. Bowles, "Scientific Indoctrination in Future Army Air Forces," Folder "War Effort: Postwar Plans...1945," Box 3, E.L. Bowles Papers, NASM. In November 1945 Bowles testified before the War Department's War Equipment Board and suggested "for the sake of safety, we will have pre-planned integration...a planned economy, you might say." See testimony from E.L. Bowles, War Department Equipment Board, 16 November 1945, p. 3, Folder "12107--Testimony of E.L. Bowles Before the War Department Equipment Board, 11/45," Box 2, E.L. Bowles Papers, NASM.

trol of the service's critical activities. This perspective dovetailed with the application of business models as a means for managing service interests in a period of demobilization and reduced funding.

On October 4 Robert Lovett, Assistant Secretary of War for Air (the civilian authority in the War Department responsible for the Army Air Forces) wrote Arnold to raise this very point. Lovett had been a banker prior to joining the War Department in 1940 and had pushed for the application of business practices to service aircraft production efforts.[17] In the postwar period he saw an even stronger need for the thoroughgoing incorporation of business methods into service management. Lovett directed Arnold to create an office of Air Comptroller, which would report to the Commanding General and serve as a site to advocate and institutionalize such methods.

Lovett recalled that "during the war one of the outstanding accomplishments of the Army Air Forces was the adaption of certain basic business principles to military needs and the handling of problems that are essentially those of a business enterprise."[18] Wartime had made the service an institution with global

17. Lovett was part of a small group influential in the War Department who had their roots in New England business and society. These included Lovett, W.A. Harriman, Dean Acheson, J.J. McCloy, George Kennan, and Charles Bohlen. On this point see Walter Isaacson and Evan Thomas, *The Wise Men: Six Friends and the World They Made* (New York: Simon & Schuster, 1986), especially chapters 6-7.

18. Memo from Lovett to Gen. Arnold, 5 October 1945, p. 1, Folder "Organization and Functions, DC/AS, R&D," Reel A1761, C. LeMay Papers, Office of Air Force History.

responsibilities. That charge would remain in peacetime, but reductions in budgets would only make the service's job more complex. Service leadership would have to exercise "more accurate selectivity of projects and a more intense follow-up of the application of the limited funds allocated...."[19] Every dollar allocated must go to the most needed project and deliver a full dollar's worth of results. This situation, Lovett continued, "called for the best type of business management. Sound business practice requires...a system which can provide an organized, completely coordinated and budgeted AAF program."[20] And rigorous business management would have to include the "increasingly important research activities" of the service.[21]

Bowles's thoughts on connecting questions of management with research centered on strengthening Arnold's hand within the service and with industry and academia. Lovett was reminding Arnold of another audience: Congress and the President. An Air Comptroller would enhance internal management controls, but more important increase the service's ability to argue for and defend its budget and expenditures. The penetration of business practices throughout the service in the reporting and tracking of personnel, supplies, facilities, and projects would provide military leadership new means to assess and control service activities. Such a change would shift control, authority, and decision-making from lower organizational levels, particularly commands, to the Air Staff. The Commanding General

19. Ibid.

20. Ibid.

21. Ibid.

and service leadership, in theory, would have more confidence in the programs the service undertook and could offer a more persuasive case to political decision-makers.

Lovett did not seek the establishment of the comptroller's office on grounds that efficiency, economy, and control were generic, beneficial business values. He was part of the small group of service leadership, civilian and military, actively trying to construct an air force designed for the postwar period. He argued that one conceptual tool for shifting from war to peace was "the recognition that the Air Force is a business enterprise."[22] With the anticipated retrenchment of budgets and resources in the postwar period, economy, efficiency, and control were strategies for dealing with an institutional environment markedly different from that of the war years. Establishing practices associated with business management and installing a comptroller could turn such diminution of support into a relative virtue, increasing information and controls for service leadership. In the postwar period the "creation of an Air Comptroller would merely anticipate what the other services would someday do under the twin pressures of economy and efficiency."[23] Lovett's call for a comptroller was, thus, in part preemptive. It was to prepare for a dramatic decline from the high levels of wartime military spending and to position the Army Air Forces to compete better with the other services for a scarcer military dollar. The rhetoric of economy and efficiency might be as effective in budget and military politics as it had been in business.

22. Ibid., p.2.

23. Ibid., p.2.

Lovett's communication to Arnold recast the stakes in defining the postwar fate of research in the military: Would research come under a new deputy for research and development or under a comptroller, and which position would have prominence in the organization? Through October and into November, Bowles, Arnold, Spaatz, and Ira Eaker, the Deputy Commanding General under Arnold, worked over this question, grappling with the problem of how to organize the service to reflect the implications of an ideology of preparedness. Internal functions and decision-making, as well as relations with external sources of science and technology, needed to be defined. During November 1945 Arnold hesitated over how to accomplish this. Through Ira Eaker, Arnold informed Lovett on 7 November that Curtis LeMay would fill a newly created post of Air Comptroller General. By 23 November Arnold and his staff changed course and gave priority to the research and development position. By late November it had been agreed that the "Research and Development function should not be charged to an Air Comptroller General, but that the planning, coordination, and supervision of AAF Research and Development were of such importance as to warrant particular consideration"--in short, the position of Arnold and Bowles had been ratified.[24] LeMay now was designated as the head of this new post. By early December, Bowles, Major General Curtis LeMay, and Major General Lauris Norstad established the policy and operating guidelines for a new Office of DCS/R&D. Later that month the new

24. Memor from LeMay to Gen. Eaker, 23 November 1945, p. 1, Folder "Organization and Functions, DC/AS, R&D," Reel A1761, C. LeMay Papers, Office of Air Force History.

office began business. The Office of the Air Comptroller would not be established until summer 1946.

LeMay was one of the rising stars of the service, distinguishing himself in B-17 campaigns over Europe and especially in attacks against Japan as commander of the Twentieth Air Force. Arnold was keen to place him in an important position that would recognize his war accomplishments and position him for further responsibility. In choosing to give priority to the research and development position, Arnold was also indicating that this was the best use of one of his finest officers.

But it also confirmed Arnold's and Bowles's longstanding convictions on the singular importance of research in service life. They did not reject Lovett's business analogy, but embraced only the narrower lessons of corporate research management and deferred putting in place strategies for tracking and control of budgets and programs. The new LeMay position was a realization of several of their goals for reforming science and technology in the service. First, it moved decision-making on new technology up the chain of command from the technical branches to the Air Staff. It also provided a new institutional site which could be used to create a cadre of military professionals adept in the management of research. Finally, it provided a top management conduit to industry and universities and to the proposed National Military Establishment and the proposed NRF, if and when they were created.

A description of the LeMay position is revealing. Part of his duties were "to direct and supervise the AAF agencies concerned with applied research, development, and test programming," thus attending to questions of intraservice control and coordination. With the unknowns of unification and the proposed NRF looming, the position also served to stake out the service's special duty to correlate research with its own mission and with future weapons. In preparing the findings of the October-November study group, Bowles noted that "the Air Forces have the fundamental responsibility for ensuring that the nation is prepared to wage immediate and effective air warfare. This responsibility cannot be delegated to any other government agency or scientific body."[25] The new office would be a position for elaborating connections to industry and academia. Bowles suggested its central place in a November 1945 letter to Arnold: "...we must have an office that commands the respect not only of the operational military, but also of the industrial research laboratories and professional scientific and technological bodies, such as our educational institutions and research foundations."[26] With this charge LeMay would arrange the finalization of the Douglas contract in March 1946, which had been tabled until Arnold and Bowles had resolved the issues of research organization. LeMay would also oversee von Karman's SAG, which would issue its report during December 1945 as LeMay was beginning his new post. To enhance relations with external institutions the LeMay office was to employ two civilian scientists of the "highest caliber" available under Civil Service pay scales. The

25. Bowles's draft of letter for Gen. Street to Arnold, 27 November 1945, Folder "War Effort--PWP...DC/s R&D," Box 3, E.L. Bowles Papers, NASM.

26. Letter from Bowles to Arnold, 26 November 1945, Folder "WE--RAND Oct. 1945," Box 1, E. Bowles Papers, NASM.

civilian director, Bowles stated, would be "not a long-haired scientist, but a man who commands the respect both of the scientists and technologists." He would be a person as Bowles put it, "who has the confidence of the President of Bell Laboratory, the head of the GE Research Laboratory, the heads of our MITs and Caltechs."[27]

The initiation of the Douglas missile proposal and the creation of the office of DCS/R&D were two significant realizations of Bowles's and Arnold's postwar aspirations. Their rhetoric and efforts at institutional reform amplify the two interpretive starting points contained in accounts of service history in the period: the quest for institutional autonomy and the narrative of interservice rivalry. The drama often has been portrayed as one of conflict among factions of military and political leadership, especially as the war ended and discussions began on questions of military organization and unification.[28] Although important, these overt actions in the political arena constituted only part of the story. Also critical was the institutional refashioning argued for by Arnold and Bowles. The road to service autonomy was not only through political suasion in Congress, the War Department, and with the President, but through the creation of an organization that was functionally self-sufficient--or that at least could protect its interests skillfully. Missing, or at least subdued, in the few accounts of the Air Force at the end of the

27. Ibid. The AAF was never able to recruit a well-regarded industrial or academic scientist to work with LeMay.

28. The best accounts are Michael S. Sherry, *Preparing for the Next War: America Plans for Postwar Defense, 1941-45* (New Haven: Yale University Press, 1977), and Perry McCoy Smith, *The Air Force Plans for Peace, 1943-1945* (Baltimore: Johns Hopkins University Press, 1970).

war is the sense that Arnold was pursuing a broad, integrated vision for securing the service's place in the postwar political landscape. This vision combined arguments in political forums over autonomy, unification, size of the postwar military, Universal Military Training (UMT), *and* internal reforms that would enable the service to act with broad discretion, protecting and furthering the institution's interests.[29]

Well before the end of the war, then, Arnold and Bowles highlighted the ways in which they hoped to recast the service to prepare it for a new place in the military establishment. One was to adopt forms of organization modeled after business, such as organizing by function, promoting new skill specializations, and, especially, increasing the managerial and policy controls of the top leadership over the institution. The other was to incorporate aggressively the resources of science and technology into the Air Force. The first provided leadership control over the activities and resources of the institution, the second represented access to the resources "most important of all" for the postwar Air Force.

This emphasis on Arnold and Bowles as agents of change and as critical personalities in a complex, large institution may seem overdrawn. The Air Corps at war's end was one of the largest concerns in existence, employing more personnel and controlling a budget larger than any United States business of the period. Arnold had many able assistants and colleagues in the professional military and in the civilian offices of the War Department. Others during the war recognized the

29. On Arnold and UMT see Chapter I, note 41.

need for the burgeoning Air Force to adopt business practices and modes of management to gain control over far-flung and numerous activities, especially the mass production of fighters and bombers. And the gospel of science and technology was pervasive throughout the military establishment and the civilian scientific community after the perceived successes of Vannevar Bush's Office of Scientific Research and Development (OSRD) and the individual services' own experiences with new devices on the battlefield. Arnold's and Bowles's special ability was to see these lines of change as adaptable in reinforcing the goal of service autonomy and institutional self-sufficiency. Arnold did not have a specific, well-articulated plan linking autonomy, managerial control, and technology. Rather he had a consistent and powerful vision that intertwined these themes, making autonomy, strategic theory, and preparedness seem mutually supporting necessities in the postwar world.[30]

The sweep and depth of this vision distinguished Arnold within the circle of Air Force leadership and provided him with a conceptual framework for making choices and selecting opportunities to mold the Air Force to his vision. Arnold's and Bowles's ideology defined a specific institutional outlook, with unabashedly self-interested focus, shaped less by specific strategic threats and more by military and domestic politics. Within political theory on bureaucracies and interest groups, such self-interest seems unsurprising. What makes this institutional self-

30. The argument that Arnold and a small number of other officers and civilians constituted the dominant leadership cadre during and just after the war is made in Herman S. Wolk, *Planning and Organizing the Postwar Air Force, 1943-1947*, note 1. See especially chapter 6.

interest of note are the resources and political standing of the Army Air Forces and other services at war's end. They had a special capacity to act on that self-interest and to advance specific views of military, state, and society relations through rhetoric, contracting practices, and new offices such as the LeMay post.

With Arnold's retirement in early February 1946, Bowles would lose his greatest patron and ideological companion. But he would push forward their experiment linking the service to industry and academia. Bowles would return to the Douglas missile proposal and help create Project RAND.

The RAND Contract

The 1 October 1945 meeting of Arnold, Bowles, and Douglas Aircraft's Collbohm, Raymond, and Douglas was the first step in a several month process to establish what would become Project RAND in March 1946. It was also the start of a longer process of defining the relationship among the service, corporations, and technologies when planning for and conducting war over intercontinental distances. Arthur Raymond's talking points for the October 1945 meeting combined a program of engineering study for component technologies of a guided missile and a clear goal to manufacture a "physical article."[31] The Douglas representatives seem to have come to the meeting with a mix of intents. One was to build on Collbohm's and Raymond's experience with Bowles during the war. All accepted the idea that conducting studies of nascent technologies and their military applica-

31. On Raymond's outline of Douglas Co. interests see the beginning of this chapter.

tion was a distinct, functional tool for management in directing weapons development. The prospect of close collaboration with service leadership on research and planning must have seemed an unprecedented and desirable business opportunity. Such work offered the possibility of a new line of business activity--ongoing planning and managerial support to the military on scientific and technical matters. It also promised direct participation in the deliberations of service leadership on technologies--such as long-distance missiles--that would undoubtedly be central to the future service and to industry. The precipitous decline in production orders from wartime levels already had begun, and Arnold's quick decision to set aside $10 millions for the project must have only reinforced Douglas's, Raymond's, and Collbohm's interest in pursuing a collaboration with the Army Air Forces.[32]

But the Douglas Company, like other aircraft firms, was first and foremost a manufacturer. Its experience, expertise, and animating spirit were in the building of aircraft. If Hap Arnold's enthusiasm was any marker of the future, the guided missile could be an important manufacturing opportunity. Raymond's suggestion that Douglas build a physical article rather than merely provide a series of engineering studies reflected expectations of past practice. Douglas, like any other manufacturer, would expect to build what it had designed. And at this meeting in October 1945 neither Arnold or Bowles appeared to differ with this presumption.

32. On the politics of the services, Congress, and the aircraft industry in the first years after the war see Frank Kofsky, *Harry S. Truman and the War Scare of 1948* (New York: St. Martin's Press, 1992), chapters 1-3. Kofsky's useful research, however, is marred by a tendentious argument that President Truman orchestrated the "war scare" of 1948 in order to increase appropriations to benefit the industry.

The missile, of course, was a point of entry into understanding and developing expertise on important component technologies--propulsion, navigation and control, and materials, each of which might generate its own offshoot business opportunities later on. Raymond and Collbohm were particularly keen on exploring the possibilities of nuclear propulsion.

Throughout the fall and into early 1946 these overlapping but different possible directions for the Douglas project were left unresolved. The service itself complicated resolution of these questions. Although Arnold charged Bowles to follow through on readying the contract, Bowles had no direct responsibility in this area. The Army Air Forces Air Technical Services Command (ATSC) had in its purview all research, development, and production contracts. By the end of October, Brigadier General L. C. Craigie, Chief, Engineering Division of the command, sent to the Douglas Company a request for a proposal for an engineering study for a family of missiles with very specific parameters of performance.

The proposal began by stating that "the Air Technical Service Command had established military characteristics for self-propelled, ground-launched guided missiles for the destruction or neutralization of surface targets, both water borne and land, at flight distances up to 5000 miles from the launching point. It is contemplated that four types of missiles will be developed, each to be used for one of four operating ranges tentatively established as 20 to 175 miles, 175 to 500 miles, 500 to 1500 miles and 1500 to 5000 miles."[33] Other parameters of performance

33. Letter from L.C. Craigie to Douglas Aircraft Company, 31 October 1945, folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM, p. 1.

were also laid out. These included general desiderata such as ensuring "maximum freedom of the controls, propulsion unit, and fuzes from natural, enemy, or friendly interferences."[34] Many specific design features were also called for, such as systems permitting "a rate of fire of at least one missile every five minutes from each individual station," that "remote control equipment or methods of navigation be such as to handle simultaneously 600 to 2000 missiles respectively," and "accuracy of each missile should be such that 50 percent of all missiles launched strike within 500 feet of the aiming point at 175 mile range, within 1000 feet at 500 mile range, within 2500 feet at 1500 mile range, and within 5000 feet at 5000 mile range."[35] Craigie's letter concluded by saying that if Douglas was interested in "working under Government contract with the development of any or all of the four types of guided missile...it is desired that you submit a proposal outlining a one-year research program which will result in a practical design."[36] The proposal was due by 1 January 1946.

Craigie's proposal contained none of the ambiguities presented by the Douglas Company but also deleted (perhaps intentionally) a critical goal of Arnold and Bowles: collaboration between the service and industry in planning. The project for them could be a means to workable missiles *and* to reconfigured relations between the service and external sources of expertise. Craigie's quite specific requirements ran counter to Arnold's and Bowles's working assumption: that mis-

34. Ibid.

35. Ibid., p. 1-2.

36. Ibid., p. 2.

siles and their incorporation into the service presented new challenges that required study to be properly defined.

But Craigie presented the project as a typical study-leading-to-development initiative and structured his proposal to be consistent with the ATSC's past practice. The Command as purchaser defined a product, and industry could respond to build the desired item. The idea of a research and development contract, for the command, implied this relationship between the service as purchaser and industry as supplier. This interpretation was codified in War Department regulations on contracting. Craigie and his predecessors used these regulations as a means to channel decisions on research, development, and procurement through the command. No formal discussions had taken place--or were to be expected--among service leadership, planners, operations personnel, and the ATSC on what the missiles might be used for, how, and by whom. The specifics of the proposal were rooted only in Arnold's enthusiasm, an ongoing exploitation of German work on the V-1 and V-2, and a rush by the services to extend weapons research pursued during the war. In fact, from October 1945 through April 1946, Craigie's command let twenty-eight different guided missile contracts aimed at developing the family of missiles identified in his proposal to Douglas.[37] This abundance of contract activity was handled in accord with past practice. The Command initiated contracts for new equipment and technologies through an informal process of consultation which gave them considerable latitude in acting independently of other

37. Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960* (Washington, D.C.: Office of Air Force History, 1990), p. 8.

parts of the service organization and in controlling the service's relations with industry and universities. The Command carefully guarded its prerogatives for defining and managing the introduction of new technologies and the business of procurement. Craigie's letter to Douglas reflected the strength of this past practice.

Craigie's proposal to the Douglas Company ran counter to Arnold's and Bowles's plans to refashion decision making on science and technology in the service. Although Arnold's plan left ambiguous the organizational changes required to achieve this end, Bowles's vision was more specific. The post of DCS/R&D and the Douglas contract were part of a strategy to undermine and change the ATSC's control over the processes of research, development, and procurement.[38] The research and development post, ranking just under the Commanding General and his deputy in the service hierarchy, would focus decision-making on science and technology at the top of the organization, not in the ATSC. The contract with Douglas would provide an alternate conduit of expertise to service leadership, breaking the command's monopoly. Together these changes could substantially limit the scope and authority of the command's control over crucial decisions on science and technology.

38. This motivation was apparent in planning for the DCS/R&D position in fall 1945. Draft planning documents for that post proposed establishing a consultant board, with membership similar to the SAG, to review service programs and creating a "large research laboratory on military air science" with the power to let contracts. Such changes would have substantially undermined the role and authority of ATSC. On these proposals see Folder "Organization and Function, DC/AS, R&D," Reel A1761, C. LeMay Papers, Office of Air Force History.

The practices associated with service contracts in general would become the means for contesting Bowles's and Craigie's differing concepts for managing science and technology within and outside the service. Both men shared the basic assumption that the contractual process was the strongest thread connecting the military with civilian sources of science and technology. Alternative approaches for linking the military and civilian--such as the nationalization of key industries as in Britain and France--were unlikely in American political culture. In the United States the contract would remain the principal tool for implementing state interests through private industry. But the contract was an instrument flexible enough to embody different concepts of internal management of the service and of its relations with the private sector. In fall 1945 Bowles sought to change the meaning and use of the contract for research and development within the War Department and the Army Air Forces.

Anticipating Craigie's approach to the proposed project, Bowles asked Collbohm soon after their meeting on 1 October to assist Lt. Colonel H.E. Brownfield in the office of the Assistant Chief of Staff, Materiel, in drafting the Douglas contract. This office had oversight of the ATSC. Brownfield was sympathetic to Bowles's efforts. One of Bowles's aims was to expand the meaning of research and development contracts. The ATSC had used contracts primarily as legal and managerial instruments to purchase specific, well-defined products. Bowles wanted to redefine such contracts to connect the Army Air Forces leadership to persons or institutions who possessed specialized knowledge.

The model was the OSRD contract used during the war.[39] Through Brownfield, Bowles sought to create a standard contract for research and development similar to that employed by OSRD. The distinguishing feature of these contracts was that they did not call for an end product, such as a weapon or device, with specific performance parameters. Instead, such contracts constituted agreements to carry out research or development in a given area of interest. In fall 1945 the letting of such contracts required a special waiver under War Department regulations for research and development. In a 1946 memo to the file Bowles related, "My reason for wanting Brownfield to get together with Collbohm was so that we would be sure to set up the Douglas job with the same basis of freedom that characterized the OSRD contracts, and at the same time, to add the necessary conditions to insure a peacetime interest in contracts of this sort."[40] After working with Brownfield in October 1945, Collbohm presented the case for the OSRD contract form and its implications for the proposed Douglas project:

> ... it is quite evident that the standard forms of supply contracts that are now approved are not directly applicable to the type of research and development work that must be done in the future to maintain our leadership in air power. By its very nature, it is not possible in research work to guarantee exactly what will be delivered and when. ... The Comptroller General has ruled that the AAF may use the OSRD form of contract when the work to be accomplished is of the same nature as was done during the war under these OSRD contracts.[41]

39. A standard OSRD contract is appended to Irvin Stewart, *Organizing Scientific Research for War* (Boston: Little, Brown and Company, 1948), pp. 347-352.

40. E. Bowles Memo to the File, 4 March 1946, p. 2, Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM.

41. F. Collbohm, "Research and Development Contract Long Range Air Power," n.d., Folder, "WE=RAND October 1945," E.L. Bowles Papers, NASM. The inclusion of this document in Bowles's working materials from fall 1945 strongly suggests it was prepared shortly after the 31 October letter from Craigie to the Douglas Co.

On 26 November Bowles reported to Arnold on his progress in implementing the "intercontinental controlled missile program." One step, which was nearly complete, was the establishment of the DCS/R&D. The other was "the type of contract we should have for this broad kind of work represented by the initial attack on the missile program."[42] Bowles continued that he had investigated the kind of contract "that will be inviting to the organizations upon which we would necessarily depend. The form must be radically different from the ordinary contract calling for a product." In addition to his own reasons for seeking a new contract, Bowles advanced competition with the Army Air Forces sometime rival, the Navy, as another motivation to follow through: "I have also taken pains to be sure that we set up a contract of this character that is on a par with similar contracts already used by the Navy Department in connection with its research program. Only in this way will be able to protect our own interest against their competently aggressive methods."[43]

42. Memo from E. Bowles to H. Arnold, 26 November 1945, p. 1., Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM.

43. Ibid., p. 2. In referring to the Navy's "aggressive methods," Bowles was probably alluding to that service's active efforts to establish what would become the Office of Naval Research in August 1946. By May 1945 the Navy had established a provisional office to support university scientific research. In fall 1945 Admiral Bowen, head of the new office and of the Naval Research Laboratory, traveled around the country "with promises of research funds." Bowen quickly made good on his offer. In February 1946, he and his staff announced that contracts for research had been negotiated with forty-five schools and corporations. On this see Daniel J. Kevles, *The Physicists* (New York: Knopf, 1978), pp. 353-356. Bowles was also undoubtedly aware of the Navy's active missile program, including investigation of the possibilities of placing a satellite in earth orbit. This work is described in R. Cargill Hall, "Early U.S. Satellite Proposals," *Technology and Culture* 4 (1963):410-434.

In attempting to adapt the OSRD form of contract for service research and development work, Bowles did more than liberalize the scope of such contracts. This was also a step toward redefining research and the relations such contracts implied among the service, industry, and universities. The OSRD contracts during the war were intended to connect research with an eventual application in a weapon or device. The less specific nature of these contracts was intended to accommodate the uncertainties of translating research into a militarily useful device. The proposed Douglas contract reflected this same connection between research and an eventual weapon. But through the Douglas contract Bowles was also extending the concept of research to embrace a collaborative planning and managerial relationship. Research in this case might mean a simple preliminary study leading to a device or weapon, or could expand to encompass the complex social relations embedded in a particular technology, including the relationship between industry and the Army Air Forces.

In December Bowles sought to reduce confusions on the aims of the Douglas contract and bring out the managerial and political implications of his ideas on research and development contracts. He directed his attention to the multiplicity of missile projects underway, covering a range of weapons for different distances and purposes as described in Craigie's earlier proposal to Douglas. In a memorandum to Arnold, Bowles warned that "the scope of devices is so broad as to provoke dangerous opposition from outside the Air Forces...and hinder the kind of development which is consistent with and essential to our mission as a Strategic Force. The dispersion of effort, if allowed to continue, promises to becloud issues and to divert our limited energy to a degree inimical to our chief objective."[44] The external opposition was the Navy and some Congressional overseers. But this reference was intended to suggest the urgency of the issue and to highlight the internal concerns which were Bowles's primary interest. The problem was that the missile effort was, by past practice and default, largely within the purview of the ATSC--which pursued missile projects, in Bowles's estimation, without rigorous coordination with service leadership. Corporate control was lacking. Rather than developing missiles which would serve the primary objectives of the organization, the Command acted "by the prevailing idea that we must have a military characteristic before we can have a program, and that this military characteristic must express a physical gadget. It is as if we are prophets, able to visualize a thing unborn."[45] The tail was wagging the dog.

The missile program, Bowles argued, needed to be actively managed by service leadership--the Commanding General, the Assistant Chief of Plans (responsible for war plans and strategy) and the new DCS/R&D--and developed in collaboration with the Command. In particular, service leadership should give highest priority to the intercontinental missile in this area of research and development. Such a decision would clarify the service's distinctive contribution to national defense,

44. Memo from E.L. Bowles to H. Arnold, "Controlled Missile Program," 10 December 1945, p. 1, Folder "War Effort PWP...Controlled Missile Program," Box 1, E.L. Bowles Papers, NASM.

45. E.L. Bowles, "Extension of Strategic Air to Include Stratospheric Techniques," December 1945, p. 3, Folder "War Effort PWP ... Controlled Missile Program," Box 1, E.L. Bowles Papers, NASM. This document was a background paper Bowles wrote in preparation for his memo to Arnold.

strengthen internal management, and quell external criticism of the service's missile projects. Bowles recommended that "our entire controlled missile program stem from a basic study made under the immediate direction of Plans...and that the policies and development of controlled missiles be based upon the best combined thinking of our strategic specialists and our scientists and technologists in this field."[46] Bowles continued to recommend "that it be recognized once and for all that a research program is the means leading to the formulation of the military characteristic for a device and not the reverse; and that for this reason and to obtain the services of the best talent, we therefore set up research programs for this express purpose, contracting for research studies not equipment....that in the interest of the future we at once get underway a broad research program free from the strictures of the usual military characteristics in which we have as the basic objective an intercontinental stratospheric vehicle."[47]

Research thus defined implied not just laboratory activity but was a functional component of management. Bowles explored this additional connotation of research in a background paper for his memo to Arnold. As during the war, the analogy to the corporation informed his thinking:

> Any long-range program of research and development must come from the sublimated efforts of our best professional militarily strategic minds, and our best professional scientific and technological talent. In fact, the broad policies determining our strategic operations, involving the advancement of facilities, equipment, and techniques must be generated in this manner and have their initiation from top level. Only in this way will the

46. Ibid., p. 1.

47. Ibid., pp. 2-3.

Air Forces be assured of secure, comprehensive and stable planning, policies and programs.[48]

Like model corporate officers and their board, military and civilian scientific leadership would direct the service, creating a hierarchy of relationships connecting the driving goals of the organization with its particular activities. To give clarity of purpose to management, research, and relations between the Air Staff and commands, service leadership needed to identify and affirm a basic mission, a place in the market. Echoing Arnold's passion on the future of technology and the service, Bowles argued that:

> ...stratospheric air is inalienably destined to be a part of the natural evolution of air or space operation, whether considered from the standpoint of strategic bombardment or ordinary transport. If this position is sound, and if the Air Forces are to preserve their present strategic function, let us not permit our enthusiasm to lead us into activities which will threaten their position....Our program should proclaim our objective. It should be clear that strategic air is our claim....The field is one the Air Forces dare not ignore. Now is the time for them to consolidate their interests if they are to continue as the custodians of strategic air.[49]

And research, as Bowles conceived it, would be instrumental in providing the knowledge to clarify these institutional aims. The first step was to follow

48. Ibid., p.3.

49. Ibid., pp. 4-5. Under the heading of guided missile development the service was either considering or working on projects ranging from a 5000-mile missile to anti-aircraft and field rockets. Craigie's October letter to the Douglas Company suggests the scope of possibilities being evaluated. Bowles was worried that all this activity would obscure the strategic warfare mission. Bowles's call for service leadership "to consolidate their interests" was also politically pragmatic. The War Department and the Joint New Weapons Committee of the Joint Chiefs of Staff were examining the roles of each of the services in missile development. A clearly focused and organized missile effort would be useful in the ongoing interservice competition with the Army and Navy. This sorting out of roles and responsibilities had begun during the war and continued into the Eisenhower administration. A useful account of these interservice tussles can be found in Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960*, note 37, chapters 1-4.

"industry and other areas [which] have long since separated research and development from production engineering and manufacture of products."[50] Research, thus separated, would become part of corporate planning and management, serving two functions. Research would be an aid to a process of continual corporate self-assessment, in which activities and programs could be judged against the basic mission of strategic air and the resources and organization required for its implementation. It would also provide the knowledge for choosing and developing specific weapons and devices and for studying their relation to strategies for waging war. In an ironic twist, Bowles's model of the corporation was more centralized and hierarchical than the existing practices of the Army Air Forces.

Bowles's efforts in the first few weeks of December achieved several ends. His reflections and memorandum to Arnold articulated a carefully wrought corporate model for the Army Air Forces. This model intertwined the possibilities of the guided missile, the service's distinctive mission in defending the country in the postwar era, the role of leadership and the commands, and a redefined sense of research into mutually supporting elements of a new framework for the service. Bowles sharpened his thoughts on the Douglas contract, seeing it as a means for helping to realize this model of the service. The earlier ambiguity of whether the contract would cover the development of a "physical article" and future production was resolved. The research pursued under the Douglas contract would be an instrument for management to assess the implications of the new technology. The

50. Ibid. Bowles extended the analogy further: "In the industry there is, in general, another subdivision--that of sales. The sales function corresponds somewhat to our 'operations'."

deletion of a "physical article" from the contract may have been warranted by the challenges of missile technology, but this strategy was also a means to advance Bowles's conception of a proper organization of the service and its relations to science and technology. Research framed in the context of the needs of Air Staff planners (rather than the ATSC) would take as a starting point the broad aims of the service--both with respect to the organization of institutional resources and to fundamental assumptions on the fighting of future wars. With this clarification of his own approach, Bowles could engage more effectively the position of ATSC.

By December 1945 Bowles and Collbohm had reached an understanding on the purpose and broad tasks of the contract. As an extension of his October discussions with Brownfield and interchanges with Bowles, Collbohm drafted "Research and Development Contract: Long Range Air Power" as a basis for negotiation with the ATSC on the aims and scope of the contract. It echoed, with less elegance and clarity, the assumptions of Bowles and other postwar planners such as Vannevar Bush: that war had demonstrated the necessity of close "teamwork between science and the military in the development of decisive new weapons," that this relationship should be continued in peacetime, and that something needed to be done to replace the incentives of war as a means for hiring "top caliber scientists to work on military problems." Development of missile hardware receded into the background.

Collbohm offered that the purpose of the project was "to provide means for establishing an effective teamwork of science, engineering, industry, and the military with the objective of determining an optimum system for conducting long-range air warfare." This would have to be done using existing organizational tools: proffering part-time consulting positions to leading scientists; extending sub-contracts to industry and universities; and building a "full time staff of experts to receive, organize, and analyze all of the information delivered and insure that everything is adequately cross-checked." Borrowing from Bowles, the draft stated, "continuous contact will be maintained with the Air Forces, so that planning agencies will have up-to-date knowledge at all times. It is felt that this method of operation will make available to the AAF more outstanding talent than any other yet considered, since it draws on the mental resources of the entire country rather than those of any one organization."[51]

The product of this contract would not be a newly-developed missile or family of missiles. It would be knowledge in the form of studies and the development of crucial component parts which might *eventually* lead to such missiles. But, equally important, the product of this agreement would be a new method for organizing science and industry to assist service leadership in addressing military problems. Another effect of the contract would be to initiate a process for defining the relevant social and technical context in which a missile would have meaning and use. The October proposal of the ATSC implicitly defined the missile as a collection of desirable performance features--flight distance, accuracy within a

51. All quotes from "Research and Development Contract: Long Range Air Power," December 1945, p. 1, Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM. On the contract issue in December 1945 see also Collbohm letter to Bowles, 13 Decmber 1945, Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM.

certain scope, types of navigation and control systems to be used, and other parameters. The starting point of the Collbohm draft was much broader: "The subject matter of the study covers a large number of factors, all of which must be considered in a thorough study....It seems desirable to initiate the over-all study with an analysis of those factors which are primarily of geographic, political or strategic nature."[52] One part of this, the draft cited, would be to assess domestic and overseas bases of the service with respect to "locations, capacities, ease of supply, etc., together with their relationship to all possible target areas."[53] Another would be to recognize that the challenging and expensive undertaking of developing a "power ful striking force" had to be accomplished within postwar budgets. Collbohm offered that "one of the most important points in our evaluation of the proposed system and of each of its components involves a study of its economics. We must get the most effectiveness considering the number of units, accuracy, destructive area, vulnerability, and indirect effects as well as direct effects upon our own peace time economy."[54] The missile was, thus, more than a technical problem--it was also a problem in bureaucratic relations and political economy. As such, study and planning for missiles would have to encompass all these realms and their mutual interaction.

Examination of such issues would then provide a set of criteria for pursuing and evaluating specific technologies and possibly identifying new ones--a contrast

52. "Research and Development Contract," note 51.

53. Ibid., p. 2.

54. Ibid., p. 3

to the approach of the ATSC October proposal. Collbohm's draft argued, for example, that research into technologies for reconnaissance in advance of war was part of the context of the missile. "Since possession of a force capable of accurately striking targets at great distances is of little value unless the location of the various important targets is known, it is obvious that some means of reconnaissance must be developed so that we may know where our missiles should be sent."[55] Framing the examination of missiles in this way was also a path to another objective Bowles hoped to realize through the contract: providing military leadership with an authoritative source of expertise distinct from that of the ATSC. Questions of politics and strategy were beyond the traditional scope of those responsible for military research and development. The contract, the draft argued, could "probably best be handled through A-5 (Plans) in conjunction with State, Navy, and other departments of the government."[56] The implication was that the problem of missiles--and by extension science and technology generally--was the proper concern of service's corporate leadership. In marshaling and channeling "the mental resources of the entire country" to service leaders and in defining the missile as an integral part of the service's politics and institutional planning, Collbohm's draft contract was an instrument for implementing Bowles's corporate conception of the postwar Army Air Forces.

Through January 1946 Bowles worked on securing approval for a standardized cost-plus-a-fixed-fee contract for research and development. In anticipation of

55. Ibid., p. 2.

56. Ibid., pp. 1-2.

the Army Air Forces-Douglas missile project, Arnold formally invited the comments of the Douglas Company on the draft of the basic stipulations of such types of contracts. On January 30 Douglas Vice President John Rogers responded with suggestions for changing some standard clauses.[57] By the third week of February, all the pieces were in place for defining the Douglas contract and sorting out the alternate views of Bowles and the ATSC. On February 21, only a few weeks after Arnold's retirement, DCS/R&D Curtis LeMay organized a meeting with Bowles; General Craigie, head of the ATSC; members of Craigie's staff; and, representing Douglas, Collbohm and David Griggs, who like Collbohm had worked out of Bowles's office during the war.

Bowles and Collbohm presented an outline of work which was a further iteration of their draft contract of December. The outline was in two parts: "Review of Requirements of Future Air Warfare" and "Research and Development Projects Now Contemplated." The organizing idea for the first category of work was the study of technologies central to intercontinental warfare, exemplifying Bowles's view that the strategic mission was the core of the service's institutional and political strength. This would include assessment of technologies already in existence or in development, such as B-29s, B-36s, and the atomic bomb, as well as defensive countermeasures against such weapons. The outline gave equal attention to future technologies such as long-range missiles and the development of atomic engines for aircraft and missiles. Finally, without explanation, the outline included "study of a Moon Rocket."

57. Letter from John Rogers to H. Arnold, 30 January 1946, Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM.

The second category of activity, "Research and Development Projects Now Contemplated," was part of Bowles's and Collbohm's strategy to draw "on the mental resources of the entire country" through subcontracts. The proposed project would directly support research and development of an "atomic energy engine for driving aircraft with propellers," an "atomic powered jet engine," and an "atomic powered rocket engine." It might also involve a program of development on control systems and instrumentation and on special defensive measures against "high velocity missiles, including a `Death Ray'," a directed beam of high-intensity microwaves. And, last of all, the outline of this section called for a catch-all license to pursue any other component development project that the "Review of Requirements of Future Air Warfare" might suggest.[58]

The outline presented at the LeMay meeting was ambitious. The proposed program of work embraced technologies at hand, in the offing, and those projected for the distant future. It embodied a rough sense of the means and style of long-distance warfare. But, above all, in its scope and suggested subcontract activity, the outline of work seemed a substantial transfer of prerogatives and responsibility from the ATSC to Douglas. Douglas, as Bowles intended, would have a crucial role in providing scientific and technical knowledge to service leadership.

The meeting seems to have had an anticlimactic outcome. General Craigie again presented his proposal of October, arguing for a contract similar to other

58. "Agenda for Meeting with AAF 2/21/46, Program of Work--1946-47," Folder "WE=RAND October 1945," Box 1, E.L. Bowles Papers, NASM.

missile developments that the ATSC had underway. Douglas, he argued, should work toward a missile or missiles of specific performance characteristics. LeMay then asked for Bowles's comments. Bowles's account of the meeting several days later had the air of someone placed in an awkward situation:

> Although...placing me in an unenviable position I felt obliged to speak at some length, so as to convey to the group what I thought was lacking in comprehension on the part of the proposers [ATSC], its seeming lack of understanding that future planning for the Air Forces was inextricably involved with scientific and technological development. I reviewed the relationship of a project of the breadth Douglas proposed to the ability of the Air Forces to maintain their position as custodians of air power. The subject of unification was brought in, and I tried to tie in with it the key position of strategic air.[59]

He then argued that ATSC's view that "guided missile programs were mere production programs, unrelated to overall planning and definitive top-side policy" did not meet the needs of a postwar service, and indeed was detrimental to the "Air Forces as an organic entity."[60] He then softened his stance by noting that Arnold felt that ATSC should be excluded from involvement in the Douglas contract, but that Bowles felt that he should try "to keep it in channels."

LeMay made a quick resolution of the dispute, siding with Bowles. Perhaps LeMay's decision was in deference to the recently retired Arnold. Or perhaps, as Bowles had hoped, the creation in December of LeMay's post, Deputy Chief of Staff, Research and Development had given the Air Staff an appreciation for integrating science and technology into decision-making. LeMay accepted without comment Bowles's assumption that organizing for future warfare based on new

59. Memo from E.L. Bowles to File, note 40, p. 1.

60. Ibid.

weapons and long-distance airplanes and missiles had reconfigured relations between the civilian and the military. The Douglas project would, in substance, be a managerial extension of the Air Staff. It was agreed that "Douglas supervisors would be cleared by General LeMay [i.e., given security clearances] and then turned over to Plans to be briefed on our current strategic thinking."[61] With industry as an extension of the Air Staff, information and knowledge would flow in both directions. Bowles paraphrased LeMay as stating that "the Douglas project might result in our changing our strategic thinking, and if it did that was to the credit of the project, for we were after the facts."[62]

"After a good deal of discussion and reluctant submission to General LeMay's policy" among the various parties, LeMay asked Bowles to draft a statement of work. Bowles suggested that the contract call for "A study and research on the broad problem of intercontinental warfare, exclusive of surface warfare, with the object of making recommendations to the Army Air Forces as to techniques and devices."[63] This statement was approved by LeMay and, with minor variations, was the guiding language for the Douglas contract and for the subsequent development of RAND through the 1950s.

The vagueness of the language is noteworthy. It allowed the possibility of defining the Douglas project in many different ways. In the months ahead the pro-

61. Ibid., p. 2.

62. Ibid.

63. Ibid.

ject would take shape through the process of managerial interaction alluded to by Bowles and LeMay--a continuous pattern of mutual briefing and interchanges between Douglas and the Air Staff. The ambitious outline of effort drafted by Collbohm and Bowles fit comfortably into the unrestricted statement of work. In advance of the LeMay meeting they probably consulted with friendly members of the Air Staff on what to include in the outline. The numerous areas of investigation proposed seem to reflect some initial process of consensus. This outline of work would provide a remarkably accurate blueprint of Douglas work for the next several years.[64]

On 2 March the Army Air Force and the Douglas company signed a letter contract establishing what would soon be called Project RAND, a name apparently selected by Arthur Raymond as a loose acronym of "research and development." In negotiating the contract Bowles articulated his corporate conception of the service and Project RAND's role in reforming the service to that end. But the process of negotiation and the contract itself could not change completely the role of the ATSC (soon to be renamed the Air Materiel Command [AMC]) or the practices it represented. Bowles conceived RAND largely as an alternative not a complete replacement for the ATSC. Commanding General Spaatz and other service leaders would have to use, sustain, and endorse Project RAND. The RAND Project created a faultline within the service over the control of research and development. Over the next year Bowles would have to contend with these intraservice tensions. Part of his response was to engage in the bureaucratic infighting required to protect

64. RAND's program of work will be described in subsequent chapters.

his work. Another was to author a manifesto on military research and development under Dwight Eisenhower's name to clarify for a much larger audience the meaning and purpose of Project RAND and his other initiatives.

Arnold's Retirement

Many years after Edward Bowles's service in the Army Air Forces and the War Department, he recalled the effect of Arnold's February 1946 retirement on his activities and ambitions: "When I had my back propped against Arnold, I somehow felt I was achieving something. And all of a sudden, his retirement. I guess I must say it demoralized me....My following in the Air Force was because my strength lay in Arnold. When Arnold left...I had no one to help me."[65] Bowles's recollection speaks to the close collaboration between Arnold and Bowles as well as the balance of power in their partnership. Bowles's own authority and effectiveness derived, in large measure, from Arnold.

But Bowles's comments also point to another facet of Arnold's retirement: Arnold's successor, General Carl "Tooey" Spaatz, did not fully share Arnold's vision or passion for adapting the service to a new age of air power. Arnold saw the service at the center of a new social order in which air power was a singular instrument for ensuring the United States safety and preeminence and for imposing global order in an unsettled world. Rapid scientific and technological innovation and new weapons motivated efforts for and provided opportunities for organizing

65. Edward L. Bowles Oral History, 14, 15 July and 20 August 1987, p. 94, RAND Oral History Project, NASM.

national resources to meet the challenges of the new order. Arnold's ideology of preparedness, his concepts of air power, and his belief in science and technology were all organic parts of this vision. The strongest voice for composing these elements into a new postwar social scheme receded with Arnold's retirement. Arnold's successor did not have the intensity of purpose for translating an ideological and political vision into a series of initiatives for reforming the service.

Spaatz was not and could not be the same partner for Bowles as Arnold had been. Through 1946 and most of 1947 Spaatz faced a series of issues and circumstances that consumed the limited resources of the Air Staff and the commands: creating a unified military organization with the Army, Navy, and Air Force as services of equal standing; managing wartime demobilization; and restructuring the service as budgets declined from wartime peaks. Arnold's grand vision shifted to the background. The climate was more pragmatic.[66] Army Air Forces autonomy, for example, became more an end in itself rather than a crucial and distinct part of the vision of air power and the role of the service in postwar American society. Yet the ideas that Arnold and Bowles advanced during and immediately after the war provided a basic language for defining, describing, and defending the service and its relation to science and technology. Rather than as means to forge an ideal political order embracing the service, industry, and academia, the rhetoric and ideas of Arnold and Bowles provided a background resource for Spaatz and other leaders in articulating or justifying more limited undertakings--defending a line

66. On some of the changes in the service after Arnold's departure see Robert F. Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force, 1907-1964* (Maxwell AFB: Office of Air Force History, 1971).

item in a budget, presenting the work of the SAG, or explaining the RAND contract to those outside the Air Staff.

In early 1946 Bowles perceived the changes underway. He scaled back his consulting arrangement with Secretary of War Patterson and with Commanding General Spaatz from a full-time position to a three-day-a-week activity.[67] But Bowles still saw a close association with the professional military as his best immediate career opportunity. He continued to advance the two interdependent elements of the reform program he and Arnold had begun: refashioning the internal organization of the service and its relations with science and technology.

While Bowles's ability to implement the changes he and Arnold sought may have changed, the challenge of weapons production remained. The War Department and the Army Air Forces, in Bowles's view, still needed to enhance control over science and technology at the very top of their organizations and to initiate a mechanism for planning and coordination with industry and academia. But with Arnold's retirement Bowles's leverage in pushing such initiatives was made weaker. He did not have a champion within the service and had to contend with well-entrenched practices, established by the ATSC before and during the war, aimed at managing the service's relations with academia and industry.[68] And, of

67. See letter from E. Bowles to R. Patterson, 3 June 1946, Folder "War Effort--ELB and Associates...R.P. Patterson," Box 4, E.L. Bowles Papers, NASM. While Bowles may have formally changed the terms of his military consultancy he still seems to have continued to work at a near full-time pace.

68. The ATSC was renamed the Air Materiel Command in March 1946.

course, external to the service were competing visions and programs for organizing the relations among science, technology, and the military--principally the proposed National Research Foundation and the Joint Research and Development Board.

But to this point Bowles's ideas on the military, science, technology, and postwar society had mostly found expression quietly--in conversations, memoranda, letters, and as a behind-the-scenes operator. In March and April 1946 he sought to gain a wider audience and legitimacy for his ideas. He needed a public manifesto, promulgated by and through military authorities, to make clear the meaning and significance of his initiatives, particularly the Douglas Project RAND undertaking. At this time he redirected his efforts to the War Department, pushing for a high-level staff position for research and development--established as the Research and Development Division, Army General Staff, in late April. This new office was to be analogous to Curtis Lemay's Army Air Forces post--and because the service still was an organizational subunit of the Army the new research and development post was superior to LeMay's. Bowles used this opportunity to draft a policy statement for the new office laying out his organizing concepts for postwar military relations with industry and universities. The policy paper was entitled "Scientific and Technological Resources as Military Assets" and was issued under Chief of Staff Dwight Eisenhower's signature. It would be Bowles's manifesto for developing the Project RAND at Douglas and its relations with the Army Air Forces.

Bowles, Eisenhower, and "Scientific and Technological Resources as Military Assets"

Bowles now had accomplished two crucial tasks in his effort to refashion the service to secure a prominent place for science and technology in the everyday life of the institution. First, he and Arnold had created a new focus of decision making at the top of the Army Air Forces--the DCS/R&D. Second, Bowles had engineered an institutional invention: Project RAND provided a setting in which service management could gain access to communities of knowledge (academic and industrial) crucial to understanding technology and its application to air warfare. These changes, Bowles hoped, would bring a corporate rigor and efficiency to the service, focusing "top-side policy" and providing the intellectual resources to inform and enforce this policy. These initiatives were complemented by the service's SAG. Bowles had little to do with this undertaking and regarded it as peripheral to the core of his and Arnold's efforts. The changes Bowles had worked on were designed to refashion the day-to-day fabric of institutional life and behaviors. The LeMay post and Project RAND were new organizational facts that could and should alter older patterns of practice of ATSC and others, as well as establish new patterns with academia and industry. In Bowles's view, the SAG as an intermittent advisory apparatus would have less of an impact on the ongoing work of the service.

Despite Bowles's central role in recasting structures of decision-making and of relations among the Air Staff, commands, and civilian sources of knowledge, his accomplishments remained fragile. During Arnold's leadership, Bowles envisioned a centralization of planning and decision making on science and technology in the Air Staff. LeMay's post in this scenario was designed as an important point of corporate control within the service and of contact with industry and academia. With Arnold retired, though, LeMay, new Commanding General "Tooey" Spaatz, and others would seek to redefine Bowles's initiatives in their own ways. With Arnold as service leader, Bowles had to convince only Arnold, who was usually sympathetic, to accomplish his ends. Without Arnold, Bowles position was more difficult. He had no direct institutional power or control of resources. In early 1946 his institutional leverage derived from his position as consultant to Commanding General Spaatz and to Secretary of War Patterson. He did not have the same close working ties with either man that he had had with Arnold. Bowles, by his proximity to Spaatz and Patterson, represented to others in the military, such as General Craigie at ATSC, the possibility of the invocation of these leaders' authority. But Bowles's power, when compared to his earlier relationship with Arnold, was diminished.

This shift in circumstances illuminates a special aspect of Bowles as a social actor and of the context in which he worked. He was situated in a bureaucracy in which either control of resources or an explicit position of rank or office were the basic means for action or the exercise of authority. Through his relationship with Spaatz and Patterson, he was part of this calculus of bureaucratic life. But Bowles's means for directing and organizing change was more tenuous: envisioning and articulating an ideology and program of institutional adaptation through personal interactions and, above all, through memoranda, letters, position papers, policy directives, contracts, and other textual instruments. Bowles sought through such texts to secure a particular vision of the service and implement it. One part of this process was to persuade and to negotiate by stating, re-stating, repeating, and drawing on the authority of others (such as Arnold) to gain consensus or to win over crucial decision-makers. Another was to implement change through texts such as policy directives and contracts intended, at least in principle, to regulate institutional actions and relations.

But such texts could be open to multiple interpretations and implementations, and it took constant effort to maintain a particular consensus on the meaning of a policy directive or contract. For example, the directive establishing the LeMay post or the language of the final Douglas contract contained none of the explanatory background that gave these texts their meaning to Bowles and Arnold. Without vigilance others could come to interpret them in different ways and employ them for different ends. Before Arnold's retirement, Bowles relied on him to help provide that vigilance. Without his "back propped against" Arnold, Bowles had, primarily, words and more words as defense for his two signature achievements. One way to maintain consensus was to churn out more letters and memoranda to military colleagues. Another was to generate new policy directives that reinforced the meaning of previous ones. Yet another approach was to share his ideology and thinking with broader audiences, hoping to create new allies for his views.

These last two strategies came into play in the spring of 1946. From late February through April Bowles was a part of a group of officers on the Army General Staff who defined a new War Department post similar to that held by LeMay. With unification and Army Air Forces autonomy almost a year and a half away, the air service was still a subunit of the War Department, subject to direction from the Army General Staff. Establishing an institutional place for research and development in the Army hierarchy would extend Bowles's corporate vision into another institutional setting and serve as a reinforcement of the still fledgling LeMay post in the Army Air Forces. Bowles played a prominent role in arguing for and articulating the specifics of the new Army office, which would be called the Research and Development Division, Army General Staff.

But the Army's bureaucratic dynamics of negotiation and accommodation were different from those in the Army Air Forces case. In the Army in early 1946 there already was an institutional focus for research and development on the General Staff. In 1943, with encouragement from Vannevar Bush at the OSRD and from Bowles, the Army established the New Developments Division (NDD). This office monitored new weapons possibilities, in particular guided missiles, and arbitrated "competition between those tactical and procurement arms seeking to obtain a portion of the responsibility for developing and applying such weapons."[69] The new research and development post would be an adaptation of the NDD to the postwar period. This earlier experience smoothed the way to the new post.

69. Wesley F. Craven and James L. Cate, eds., *The Army Air Forces in World War II*, Volume VI: *Men and Planes* (Washington, DC: Office of Air Force History, 1983), p. 232.

But Army bureaucratic style was more conservative than that of the Army Air Forces. As in the LeMay case, Bowles sought to attach the research and development post directly to the Chief of Staff and place it above the Assistant Chiefs in charge of the major staff divisions such as ordnance, intelligence, personnel and other elements (on the Army's staff organization see Figure 1 in Chapter I). Again, the goal was to elevate decisions on science and technology to the top of the organizational hierarchy. Bowles lobbied Eisenhower, then Chief of Staff of the Army, to position the research and development post in this way. But there was concerted resistance among the Army General Staff assistant chiefs, reflecting (compared to the Army Air Forces) a stronger tradition of consensual decision-making among the staff.

Bowles outlined his perceptions of the Army culture he hoped to change in a late March letter to Assistant Secretary of Air Stuart Symington (successor to Robert Lovett). Symington, as one of the civilian leaders of the War Department had, like Bowles, a foot in each of the two separate worlds of the War Department and the Army Air Forces. Bowles offered that:

> In my discussions with General Eisenhower some time ago I am quite certain I convinced him that the new War Department office for research...should be at higher than Staff level. Since concepts of research and development are not too well understood by Army personnel, they need to be administered with the minimum of non-concurrence. Putting the office at the Staff level means that every paper must be reviewed by every other Staff agency. Hence there is ample opportunity for resistance and opposition. Non-concurrences, as you know, have to be overcome by the Deputy Chief of Staff, and if the Deputy is busy with other matters almost anything can happen.[70]This communication reveals Bowles's per-

70. Memo from E. Bowles to S. Symington, 27 March 1946, Folder "Sci & Tech Resources as Military Assets ...," Box 3, E.L. Bowles Papers, NASM.

ception that bureaucratic politics could lead to situations in which texts like policy directives could be opened up, reinterpreted, or made ineffectual. Proper organizational placement (in this case "higher than Staff level") could help secure the meaning and power of the office and the texts that supported it.

Bowles asked Symington's help in achieving this end: "If you agree as to the level this new office should have, I am sure it would be helpful for you to express your ideas to [Secretary of War] Judge Patterson. I am quite sure he does not fully appreciate the insurance that is inherent in placing this responsibility at higher than staff level."[71] Symington apparently did not intervene with Patterson on this matter. Within two weeks, Bowles knew he had not prevailed with Eisenhower on this point. Eisenhower chose to place the Research and Development Division at the same organizational level as the other major staff divisions, dealing a significant setback to Bowles's ambition to apply the corporate model to the Army.[72] Despite his confident prediction of the outcome of this question to Symington, Bowles seems not to have been surprised by Eisenhower's decision. Bowles was well aware of and often quite acid in criticism of the Army's conservative style in research and development.

71. Ibid.

72. Perhaps Eisenhower gave precedence to the Army's staff tradition of concurrence decision making or perhaps Bowles did not have as much personal capital to draw upon in this case. Bowles's relationship with Eisenhower was professional and perfunctory. Bowles's closest personal relationship among Army military officers was with George Marshall, during the war, when Marshall was Chief of Staff.

But the establishment of the Research and Development Division still had value. In his letter to Symington Bowles highlighted the Army Air Forces interest in the new position, which was the basis of his appeal for Symington's help. The service needed to protect its political and bureaucratic position with respect to science and technology in the short term: "Until unification, the Air Forces will be definitely interested in the position of the War Department head man for research and development, since problems of jurisdiction, as between [Army] Ordnance and Air Forces for example, will have to be handled by this office."[73] Bowles was referring obliquely to the Army Air Forces interest in guided missiles, the technology which had stimulated Arnold's and Bowles's extensive maneuverings to refashion service management. During and after the war the War Department, Army Air Forces, and Joint Chiefs of Staff were constantly adjudicating disputes in the intense interservice competition to lay claim to the development of missiles. The Research and Development Division, if properly managed, could be an ally in these bureaucratic disputes, or at least help to mute Army-Army Air Forces tensions. Moreover, the new office could help secure and legitimate the LeMay post and Project RAND--as well as Bowles's hard work in fall 1945 and the early part of 1946.

The process of negotiating the Army post also created an opening for Bowles and his characteristic methods of persuasion. The significance Bowles attached to the LeMay post and to Project RAND were known only to a limited audience

73. Memo from E. Bowles to S. Symington, 27 March 1946, Folder "Sci & Tech Resources as Military Assets ...," note 67.

within the military and to a select number of industrialists and academics. Both undertakings were handled as internal bureaucratic business even though Bowles and Arnold saw them as steps toward a larger social refashioning. Bowles was particularly frustrated by his inability to convey the import of Project RAND, the achievement he regarded as his most far reaching. The Douglas contract was classified as secret and Bowles could only limn its import in very general terms to those external to the military. But in the process of creating the Army's Research and Development Division Bowles did persuade Eisenhower to issue an explanatory policy statement on the motivations and operating philosophy of the new post. This paper, entitled "Scientific and Technological Resources as Military Assets," would be issued under Eisenhower's signature on the establishment of the new office on 30 April 1946. Eisenhower's signature and its promulgation as part of a major reorganization would ensure a wide audience for Bowles's thoughts--at least in the circles of individuals active in matters of science, the military, and politics. Bowles regarded this paper as his manifesto and contribution to the postwar discussions of the place of the military, science, and technology in the nation's future.

By mid April Bowles knew he had lost the contest over the level of the new office in the Army hierarchy. But he still saw the possibility of achieving other ends through the imminent reorganization. By this time he had spent several weeks drafting "Scientific and Technological Resources as Military Assets." Part of Bowles's success as a consultant operating within the military bureaucracy was to anticipate the interests of leaders such as Arnold or Eisenhower and to invest effort in drafting speeches or policy papers *before* any need had been identified or expressed. Such was the case here. On 12 April he shared his draft paper with Eisenhower, stating "I believe that it would be of great importance at the time the reorganization plan is put into effect to issue a policy paper on the philosophy underlying the establishment of this new office for research and development."[74] Bowles sought to create an opportunity to detail his own outlook and assumptions about the connections between the military and civil society in the postwar period. The draft to Eisenhower struck the broad themes evident in Bowles's wartime work and his efforts of the last several months. Foremost among these themes was connecting the professional military--not civilian military authorities--with science and technology. Bowles continued his appeal to Eisenhower: "I have visualized this new office as a means of coupling our professional military with those outside the Army. I feel strongly the Army will gain much by a public declaration that goes beyond mere pronouncement of an interest in research and development. The breadth expressed in the attached paper is in keeping with our growing responsibilities and is consistent with the spirit of unification."[75] And to be sure that emphasis on the role of the professional military was clear Bowles urged "that this statement be issued by you rather than the Secretary [of War], since both the public and the Army must be assured that the future cooperation of the military and civilians has the backing of highest staff level of the Army."[76]

74. Memo from E. Bowles to D. Eisenhower, 12 April 1946, Folder "Sci & Tech Resources as Military Assets," Box 2, E.L. Bowles Papers, NASM.

75. Ibid.

76. Ibid.

Eisenhower's response was brief and enthusiastic: "I think this is splendid."[77] He then asked General Handy, the Army Deputy Chief of Staff, to organize a small group from the General Staff to work with Bowles in refining the policy paper. Lt. General Hull, Assistant Chief of Staff, Operations Plans Division, would lead the review. Over the next two weeks Bowles, Hull, and Generals Collins and Paul would sift through the assumptions and language of Bowles's composition. A Hull memorandum to Bowles setting up their first meeting was spare in tone. Bowles's views regarding the backwardness of the Army in research and development matters--clearly expressed in the letter to Symington and implied by his efforts to place the new office above existing staff divisions--were undoubtedly known to Hull and the others. But the group review of Bowles's draft retained most of his original ideas on the military, science, technology, and their social relations.

Bowles's paper to Eisenhower was a drawing together of ideas he had advanced, refined, and repeated as consultant to Stimson, Arnold, and others during the war and in the months afterward. His prescription for the postwar years was a combination of generic concepts such as "integration" and "education" (whose specific content was malleable and easily invested by his audience with their own interpretations) and particular programmatic ideas. Both elements of Bowles's style were evident in his draft. He began with an assessment of wartime experience shared by many in scientific, military, and political circles: "The recent

77. Eisenhower's response was written on Bowles's 12 April letter and returned to Bowles.

conflict has demonstrated more convincingly than ever before the strength our nation can best derive from the integration of all our national resources in time of war." In particular, it was the "natural and social sciences and the talents and experience furnished by management and labor" that were the crucial resources during the war and would be in the years afterward.[78] It was their integration with the military that was at stake. The burden of Bowles's paper was to argue for this concept of integration and give it more specific content.

Continuing, Bowles argued that integration in the future required the example of the past as well as explicit new understandings: wartime "integration must be translated into a peacetime counterpart which will not merely familiarize the Army with the progress made in science and industry, but draw into our planning for national security all the civilian resources which can contribute to the defense of the country."[79] Integration had an unwavering point of departure: it represented the centrality of military leadership in the postwar order. This was the purpose of issuing the policy statement under Eisenhower's signature. Together with enlightened members of the scientific and corporate communities, professional military leaders would manage civilian and military social resources for the commonweal in an uncertain future. And it called for a public ethic which would support and legitimate this enlightened management.

> Success in this enterprise does not rest upon the Army alone. It depends to a large degree on the cooperation which the nation as a whole is willing

78. Quotes from E. Bowles, "Scientific and Technological Resources as Military Assets," draft 11 April 1946, p. 1, Folder "Sci & Tech as Military Assets, ELB/DD Eisenhower," Box 2, E.L. Bowles Papers, NASM.

79. Ibid.

> to contribute. However, the Army as one of the main agencies responsible for the defense of the nation has the duty to take initiative in promoting closer relations between civilian and military interests. It must establish definite policies and administrative leadership which will make possible even greater contributions from science, technology, and management than during the last war. It must recognize at the same time that civilian assistance is not limited to technical services, but can be usefully employed in practically every aspect of our staff and command activities.[80]

This preamble on the ideals of postwar military-civilian political economy was followed by five points--all familiar from Bowles's earlier work--which would serve as steps toward and guideposts to integration. The first point was that the function of joint planning and management of science and technology required changes of culture and expectations. Military planning would need to be informed by developments in science and technology, and, in turn, these resources needed to be incorporated into the structures of military planning. The means to this integration of planning would be the contract: "There is just as much reason to contract for assistance in planning as for production of weapons. More often than not we can find much talent we need for comprehensive planning in industry or universities."[81] Bowles was sharing the background and guiding assumptions that had quietly informed the security-classified Project RAND.

This, too, was the animating spirit of the second point, which explored the professional ambience required for getting the best from those in academia and industry: "Unsuspected contributions might be secured from scientists or contractors by outlining to them the general problem before us and giving them the

80. Ibid., p. 2.

81. Ibid.

freedom to carry out their research without detailed direction. The solicitation of this type of assistance would not only make available to the Army talents and experience beyond our reach, but also establish mutual confidence between ourselves and civilians."[82] This proposition was not a nod toward an ethic of individual freedom in research but a managerial strategy. It harked back to the rationale of the LeMay post: Enlightened managers at the top of the military organization, unlike the personnel of the technical commands, would interact with civilian professionals as colleagues and equals. This was the best way, in Bowles's thinking, to get the best work.

The third point set out Bowles's concept of integration. The first two points built on Bowles's analogy to the corporation, but suggested a wider application. Society as a whole could be viewed as corporation, with each group performing a specific function as part of its contribution to the larger corporate body. A shared civic understanding of the requirements of social mobilization in modern war and the use of contracts for weapons production and joint managerial planning were tools to define and implement functional roles. But the benefits of corporate functionality might be achieved in other ways. Bowles offered that "the possibility of utilizing some of our industrial and technological resources as organic parts of our military structure in time of emergency should be carefully examined. The degree of cooperation achieved during the recent war should by no means be considered the ultimate. I see no reason why we should duplicate within the Army a commercial organization which by its experience is better qualified than we are to

82. Ibid., p. 3.

carry out some of our tasks....The advantages to our nation in economy and to the Army in efficiency are compelling reasons for this procedure."[83] Bowles cited communications and the expertise of firms such as AT&T in operating large-scale telephonic systems as a prime example. This corporate conception of postwar society recognized little distinction between a commercial firm and the military. Each performed a specific role as parts of a larger corporate society in which the military would take the initiative to guide and manage these functional relations. This insight was Bowles's adaptation of the idea that modern war was society against society, not just military against military. Bowles's slant was that a corporate model in which the military was preeminent was the most efficient way for society to organize toward the fundamental goal of survival.

The fourth point was an explicit recognition of tension within the Army and Army Air Forces over the control of research and development. The solution, in Bowles's draft and as in the LeMay post, was "within the Army we must separate responsibility for research and development from the functions of procurement, purchase, storage, and distribution." The argument had circled back. Military "administrative leadership" in a program of integration meant organizing the work of universities and industry *and* moving control of science and technology from the commands to service managers.

In his fifth and final point Bowles returned to the role of education and a shared civic understanding in promoting and securing his program. One crucial

83. Ibid.

step was grooming an officer corps to assume responsibilities in managing the nation's scientific and technological resources. Army policy should respond to the need "for officers well trained in the natural and social sciences [through] a thorough program of advanced study for military personnel."[84] The nation's universities would provide this training through new and established graduate programs and serve as focal points for the preparation of a new generation of civilian and military elite. At the same time, the policy should also provide "inducements which will encourage our men in the continued application of scientific and technological thought to military problems."[85] To accomplish the broader program of reform, the military itself would have to adapt its professional culture and provide avenues for responsibility and promotion for those with expertise in science and its management. After these institutional changes "only then can the Army obtain the administrative and operative talent essential to our task."[86]

Bowles closed out his draft by recapitulating the broad themes of integration and education. The Army faced special challenges in assuming its role as a leader in preparation for possible future war. But the Army would not shirk its duty.

> It is our responsibility deliberately to examine all outside resources as to adequacy, diversity, and geographical distribution and to ensure their full utilization as factors of security. It is our job to take the initiative to promote the development of new resources, if military security indicates the need. It is our duty to support broad research programs in educational institutions, in industry, and in whatever field might be of importance to the Army. Close integration of military and civilian resources will not only directly benefit the Army, but indirectly contribute to the nation's health and our security, as civilians are prepared for their role in an

84. Ibid., p. 5.

85. Ibid.

86. Ibid.

> emergency by the experience gained in time of peace. The association of military and civilians in educational institutions and industry will level barriers, engender mutual understanding, and lead to the cultivation of friendships invaluable for future cooperation.[87]

This was quite a charter for one office situated among competing offices in the Army bureaucracy. It is not clear what Eisenhower saw and supported in this document. Bowles's own views seem oddly disconnected from the realities of bureaucratic infighting. His corporate model was infused with politics--clear assumptions about the organization and control of social resources on a large scale. But his writing muted the hard edge of competitive bureaucratic and partisan party politics. The corporate model suggested management and choices based on good sense--the product of professional training and notions of economy and efficiency. Such management would be largely unproblematic. Education and day-to-day working relationships between military professionals and civilians would help create a shared civic understanding of the corporate model and the goal of social survival it facilitated.

This national communal ethic was crucial to Bowles's model. His program was not just an effort to link science and technology with the military but to compose a social order in which each individual and group accepted the responsibility of preparing for modern war. But preparing for such war did not end in a personal or group commitment to channel scientific and technical expertise into the military. The phenomena of this new social order needed to be studied, understood, and made part of military-civilian management. Understanding the implications posed

87. Ibid., pp. 5-6.

by marshaling science and technology for the production of new, advanced weapons on a national scale was as relevant and important as developing those weapons.

At every opportunity Bowles pointed to the need for involvement of the social sciences in his program equal to that of the physical sciences and engineering. The social sciences would provide professional insight on the political and social ramifications of organizing society for weapons planning and production. The military and civilian elite thus would be better informed in their roles as managers of social resources and as custodians of public trust. The social sciences would contribute to public understanding of the new social order and to everyone's shared responsibilities. With these civic understandings, political differences would be overcome by unanimity of interest and acceptance of each group's functional role in the whole.

Bowles's model argued for a centralization of political authority in the military but on distinctly American terms--through voluntary cooperation. Contracts; shared experiences in education and work, particularly collaboration in management and planning; and a communal ethic of personal responsibility would be the connective tissue of the corporate model. Even the idea of absorbing commercial firms into the military, for Bowles, was a testament to private enterprise and voluntarism. Such firms could do the job better than the military. The possibility of becoming an "organic part of the military" might be voluntary too--it could be a way for a firm to expand its market. Perhaps it was this very absence of overt politics that appealed to Eisenhower. Bowles's organizing concepts of integration, education, and cooperation all could be read as basic, generic virtues that stood in opposition to the sometimes rancorous fray of service or Congressional politics.

In late April this was the document that Bowles, Generals Hull, Paul, and Collins redacted. Their review of the draft policy statement resulted in two changes. One was to delete most of Bowles's references to specific examples in his enumerated points, such as in the section on making firms part of the military. Another was to delete many of Bowles's references to contracts and contractors, damping the emphasis on a specific mechanism by which integration would occur. These changes, perhaps fitting for a policy document, made the document seem more a statement of good intentions and less a plan for action. Through "Scientific and Technological Resources as Military Assets" Bowles expressed his longstanding ideas on weapons, war, and postwar American society succinctly and almost completely. It was his manifesto. And with the imprimatur of Eisenhower's name, Bowles used it to implement Project RAND in the months ahead. But the generality of many of the document's guiding concepts could and did allow others to interpret it differently than Bowles or to ignore it all together.[88]

Eisenhower issued "Scientific and Technological Resources as Military Assets" on 30 April 1946. On 2 May a War Department press release announced the new Research and Developments Division and its policy charter. The release

88. On the various drafts and the process of editing see Folder "Sci & Tech as Military Assets, ELB/DD Eisenhower," Box 2, E.L. Bowles Papers, NASM.

credited Bowles with defining the new office and its purpose.[89] Vannevar Bush, too, gave the new policy document exposure and enthusiastic support. He circulated a memorandum, with the document attached, to all former and current scientists and engineers associated with OSRD. Bush picked up Bowles's themes of continued close cooperation, education, and personal responsibility: "We should, therefore, discuss this matter particularly with the younger men of great promise with whom we have contact. No immediate and direct action on their part is called for by this memorandum. But they can be assured that the Army looks forward to a period of intense collaboration with civilian scientists and engineers, that this is a fixed and genuine policy of the General Staff, and that they should utilize every occasion to remain acquainted with military matters and stand ready to respond to opportunities to be of service."[90] Bowles, too, did his part in spreading the word on the policy paper, sending off dozens of letters to corporate leaders and fellow academics. Bowles, through Eisenhower's office, finally had a broad audience for his ideas.

Bowles's role in "Scientific and Technological Resources as Military Assets" reveals an interesting feature of discussions on science, technology, and the mili-

89. Dwight D. Eisenhower, "Scientific and Technological Resources as Military Assets," 30 April 1946, Folder "Sci & Tech as Military Assets, ELB/DD Eisenhower," Box 2, E.L. Bowles Papers, NASM; Press Release "New General Staff Group to Coordinate Military, Civilian Projects," 2 May 1946, Folder "Sci & Tech as Military Assets, ELB/DD Eisenhower," Box 2, E.L. Bowles Papers, NASM.

90. V. Bush, "To Scientists and Engineers now or formerly associated with the OSRD," n.d., Folder "Sci & Tech as Military Assets, ELB/DD Eisenhower," Box 2, E.L. Bowles Papers, NASM.

tary at war's end. The policy paper signed and promulgated by Eisenhower was one of the few written, public, official presentations by the *military* articulating its own interest in science and technology in postwar society. Manifestos and political statements on science came mostly from scientists and politicians. Bush's *Science: The Endless Frontier* and congressional maneuvering over the proposed NRF were the touchstones. Except for comment on these efforts as part of congressional hearings and in other forums the military was not nearly as expansive in public as these other groups on the political economy of science, technology, and weapons. But even the Eisenhower statement was the product of an academic, not a professional soldier. Scientific spokespersons, it might be argued, provided the basic rhetoric for discussion about science, technology, and the military in this period--whether it was to hem in military interests as in Bush's rhetoric or to promote military control as in Bowles's thinking. Bowles wrote "Scientific and Technological Resources as Military Assets" to fill this void in the Army and Army Air Forces--both to provide a counterpoint to Bush's views and to lay out an ideological argument to secure the organizational changes he had worked for within these services.

Less than a year after the end of the war Bowles's and Arnold's efforts to fashion a pattern of institutional relations featuring centralized coordination and direction exercised by military leadership seemed to have made crucial first steps from concept to reality. The purpose of these efforts was to define and enhance control over the social resources required for developing the new technologies perceived as essential in the postwar years. In particular for Bowles the fledgling technology of guided missiles provided an opportunity and test case for this undertaking in reforming the Army Air Forces and its place in American society. The Army Air Forces research and development post, the RAND contract, and Eisenhower's policy directive and imprimatur were all important building blocks.

But Bowles's attempts to centralize authority and power in the hands of military leaders would be thwarted by a number of factors: the press of activity required for unification, the tensions between AMC and the Air Staff, and alternative prescriptions, such as Vannevar Bush's, for connecting the military with industry and universities. But perhaps most telling was Bowles's own lack of political leverage. His most powerful resource was his ability, like Arnold's, to articulate an organizational vision and to map a path of reform toward it. With little more than personal persuasion, deft bureaucratic dealing, and the power of expressing his thoughts in accepted forms of institutional communication he was able to advance a vision of postwar society that competed briefly with others. His capabilities are not to be underestimated. Bowles worked in an institutional culture in which such thinking was not often encouraged or rewarded. His skill with textual communication was an important instrument for effecting organizational change. But still it was not enough. His failures and successes are revealing--about him, his milieu, the expectations for the Douglas Project RAND contract, and the choices possible for organizing relations among science, technology, and the military after the war.

Bowles's own interpretation of the concepts and social philosophy in "Scientific and Technological Resources as Military Assets" would be tested in the months ahead. Project RAND would be Bowles's opportunity to make concrete many of the ideas in the policy paper prepared for Eisenhower. But first he would have to confront Bush's competing and more widely recognized ideas on postwar organization as well as interests quite different from his own within the Army Air Forces.

Chapter III

Bowles and the Corporate Ideal: The Associationalist Vision Seen and Lost

The Douglas-Army Air Forces contract and Eisenhower's "Scientific and Technological Resources as Military Assets" provided the institutional and ideological underpinnings for launching Project RAND. This chapter will explore the ways in which Bowles built on these accomplishments to integrate Army Air Forces management and planning with aircraft industry interests through Project RAND. It will also examine the positions and reactions of others--Vannevar Bush, the Air Staff, the Air Materiel Command (AMC), Secretary Stuart Symington, Project RAND, and leaders of the aircraft industry--as Bowles pursued this objective.

Bowles's strategy for effecting this integration was reminiscent of Herbert Hoover's approach, first as Secretary of Commerce and then as President, for coordinating the efforts of the federal government and industry in controlling the uncertainties of a capitalist marketplace. Historian Ellis Hawley has dubbed Hoover's approach for managing state-market relations as "associationalism."[1]

1. A useful exposition of Hawley's views on Hoover and the concept of associationalism is *Herbert Hoover and the Crisis of American Capitalism* (Cambridge, MA: Schenkman Publishing Company, 1973), pp. 3-34.

Hoover relied on the voluntary collaboration of government and industry experts, through private organizations such as trade associations, to control and smooth out the behavior of markets. Bowles sought a similar kind of collaboration between the Army Air Forces and the aircraft industry. In this case, Bowles hoped that such collaboration would facilitate planning for weapons production and new technology--a task that seemed especially urgent as postwar budgets declined precipitously from wartime highs while the demands of technological preparedness seemed greater then ever.

Contrasting Visions of the Organization of Science and Technology

In Spring 1946 Bowles felt Project RAND was poised to fulfill its promise as an answer to a challenge posed by modern weapons and war: how to build close, continuing working relationships among the military, universities, and industry in peacetime. But as RAND took shape in 1946 and 1947, others defined this challenge in different ways, yielding different answers. Within the Army Air Forces, Bowles was well aware of the fault lines that ran through questions of science, technology, and postwar military organization. The leaders of the AMC (formerly the Air Technical Services Command) thought the tools developed to manage science and technology before and during the war were adequate for the postwar period. In their view, a system of contracting, designed to acquire specific products (hardware or research) and managed by Command personnel in consultation with the Air Staff, was still the best way to meet service needs. In the postwar era, this system would only need to be expanded and more fully supported.

Accompanying this well-entrenched practice of contracting was a familiar pattern of interest group politics, connecting the Command (as a source of contracts), aircraft firms, members of Congress, and Stuart Symington, the Assistant Secretary of War for Air. In his corporatist model of the service and society Bowles sought to work around (and perhaps naively underestimated) the political confrontation and negotiation that defined this entrenched interest group interaction. Ultimately, he could not. Bowles's corporatist model differed in an important respect from interest group politics. Bowles proposed a hierarchical social order constituted from distinct yet interdependent functional groups. Each group would accept its social role under the direction of a rational elite, headed by the military, making choices grounded in the practices and knowledge of the physical and social sciences. Interest group politics, though, were predicated on the sometimes overlapping, sometimes conflicting goals of the parties involved.[2] The motive force of this system was the self-interest of each party; agreement on courses of action was achieved through conflict and negotiation. Symington, as the service's point person with Congress, the press, and with industry understood and responded to this basic calculus of the postwar American political system. As Bowles, with LeMay's help, worked to secure Project RAND through 1946 and 1947 he had to explain the project and its purpose to Symington. Symington, viewing RAND through the lens of interest group politics, never did quite seem to

2. A useful review and analysis of the literature on interest groups and bureaucracy in the policy and procurement of weapons systems is Matthew Evangelista, *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies* (Ithaca, NY: Cornell University Press, 1988), chapter 1.

understand what Bowles was proposing. Thus, while Bowles had the support of key Air Staff personalities--including Commanding General Spaatz, Deputy Commander General Ira Eaker (the service's second in command), and LeMay--for Project RAND he had to contend with alternative, well-established conceptions of science, technology, and society represented by the AMC and Symington.

Outside the Army Air Forces, there was equal ferment in articulating relations among science, technology, and the state. Vannevar Bush pushed for two of the most significant proposals for new institutions to define and control relations between the military and the institutions of science. Each initiative highlighted different aspects of the Bush agenda; each differed distinctly from the prescriptions advanced by Bowles and the perspectives of Symington and the Air Materiel Command. The first was embodied in Bush's 1945 report *Science: The Endless Frontier* and his efforts on behalf of a National Research Foundation (NRF). Bush's report and the proposed foundation he supported may be considered as part of a strategy to ameliorate, or reverse, the transforming effects of military money and political power on elite science and its institutions. The second was Bush's successful effort to establish in 1946 the Joint Research and Development Board (JRDB) and its successor the Research and Development Board (RDB).

In Bush's view, without proper safeguards the military's expanded influence in American life could undermine the independence of science and its institutions. His response to the military's greatly enhanced ability to define working relations with the science community was to propose a political economy featuring separate yet mutually supporting roles for the military and science. The wartime Office of Scientific Research and Development (OSRD), headed by Bush, served as a model. Autonomy for science had a specific formulation. As Bush stated in early 1945 in testimony before the House Select Committee on Post-War Military Policy, chaired by Congressman Clifton A. Woodrum:

> It is a mistake to believe that since science has military importance, scientific research should be run exclusively by military men. Civilian science must clearly do the job, which by specialized training, it is equipped to do. Civilian science cannot make its true contribution, however, if its efforts are subject to the complete direction of the military or if it has no independent funds. The real answer to the problem, of course, is a partnership between the military and civilian scientists. But a true and an effective partnership can only come about if both are equals in a common endeavor. They must be equals and independent in authority, prestige and in funds.[3]

Bush's famous report *Science: the Endless Frontier*, released in summer 1945, was a manifesto for this point of view. The NRF described in *Science* and supported by Bush was designed to achieve such a balance of interests and control.

But as the effort to establish a NRF faltered in early 1946, Bush gave greater attention to a related aspect of his strategy for protecting the standing of science: coordinating and controlling the numerous research and development projects of

3. For an indication of the political context of postwar planning see Daniel J. Kevles, "Scientists, the Military, and the Control of Postwar Defense Research: The Case of the Research Board for National Security, 1944-1946," *Technology and Culture* 16 (1975):20-47. On Bush and the postwar see Daniel J. Kevles, "The Debate Over Postwar Research Policy, 1942-1945: A Political Interpretation of *Science--The Endless Frontier*," *Isis* 68 (1977):5-26; and Nathan Reingold, "Vannevar Bush's New Deal for Research: or the Triumph of the Old Order," *HSPS* 17 (1987):299-344. See also Bush's own views in Vannevar Bush, *Modern Arms and Free Men* (New York: Simon and Schuster, 1949). The Bush quote is from Kevles, "Scientists, the Military, ...," pp. 29-30.

the services.[4] Military research and development programs numbered in the thousands. And enthusiasm for the possibilities of new weapons and devices, stoked by the successes of the war, promised an ever expanding list of service initiatives. The burgeoning guided missiles projects pursued by the Army Air Forces, Navy, and Army, sometimes with duplication of effort, was an issue of special concern for Bush. These projects--the value of which were unclear to Bush--were emblematic of the service's ability to organize and control through contract university and industry research and development resources in pursuit of weapons. Military control of contracts and of decision making on the value of projects could overwhelm science and universities eager for sources of support. An equal relationship, in which the autonomy of science was respected, was contingent, at a minimum, on a system of management within the military that controlled and coordinated the research and development activities of the services. In particular, scientists should have a leading role in rationalizing and evaluating these activities. The OSRD, which was to be disbanded, could not perform this function. And the short-lived Research Board for National Security, argued over from 1944 through early 1946, was not intended to serve such a function.

Bush's opportunity to push the debate came in deliberations in late 1945 and early 1946 on military unification. The organization of military research and

4. Wrangling over political control, the representation of military and science community interests, and patent policy would continue until 1950 when President Truman signed legislation establishing the National Science Foundation. By that time the original motivation for the Foundation as a means for linking science with the military had withered. A useful account of legislative maneuvering from 1945 through 1950 from a political science perspective is Daniel L. Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, NC: Duke University Press, 1995).

development was one element of these discussions. The Joint Chiefs of Staff's Joint Committee on New Weapons and Equipment, which Bush headed, was assigned in early 1946 to devise a plan for coordinating service research and development under unification. Bush's recommendation, accepted as part of the negotiations among President Truman, Secretary of Navy Forrestal and Secretary of War Patterson, was for the creation of the JRDB, under the Joint Chiefs of Staff, to oversee and coordinate the services's research and development activities.[5] The Board, organized over the summer of 1946 and headed by Bush, was vested with authority to review all military research and development projects, rule on cases of duplication or insufficient coordination, establish project priorities, and assess quality of effort. In September 1947, with unification and the creation of a National Military Establishment, the Board was renamed the Research and Development Board.[6]

The proposed NRF supported by Bush and the JRDB contrasted with Bowles's prescriptions for the postwar period. The foundation would be a device

5. Bush's concern, mentioned above, over the services's missile research and development effort was highlighted in his memorandum to Secretary of War Patterson proposing the Joint Research and Development Board. In his seven page memo to Patterson missiles and the Army Air Forces's interest in a supersonic wind tunnel were the only two areas of technology Bush explicitly mentioned. See letter from V. Bush to R.P. Patterson, 21 May 1946, Folder "Scientific and Technological Resources as Military Assets," Box 2, Bowles Papers, NASM.

6. This discussion on the the interplay among Bush, unification, the proposed NRF, and the formation of the JRDB relies on Allan Needell, *Cold War Science and the American State: Lloyd V. Berkner and the Balance of Professional Ideals*, (unpublished manuscript, courtesy of the author), chapter 4. Needell's is the only account drawing these events together. On the maneuvering over unification during 1945-1947 see Walter Millis, *Arms and the State: Civil-Military Elements in National Policy* (New York: The Twentieth Century Fund, 1958), chapter 4.

for establishing civilian control over federal support of research, military and non-military. Control of research would be insulated from the services and from politics; scientists themselves would direct the flow of federal support to academia. The foundation as a supporter of research only--not development--would also establish a de facto divide between the contributions of academia and industry. The proposed foundation fulfilled Bush's maxim that science and the military "must be equals and independent in authority, prestige and in funds." Bowles's corporate model--subsuming science and industry into a social hierarchy in which military interests were preeminent--stood in sharp contrast to Bush's organizing assumptions. There were also profound differences between Bowles's conceptions and the rationale of the JRDB. In outline, the two shared similarities. Both relied on a managerial approach to the challenge of weapon's research and development, seeking to consolidate decision making on these issues with top leadership--for Bowles in the Air Staff, for Bush in the Joint Chiefs of Staff. And each believed that such control could be informed by the rational methods and practices of scientists and engineers. But Bowles's aim was to enhance the service leadership's control over an important resource for their institution; Bush's goal was to restrain and control the military presence in research and development by superimposing evaluation by civilian scientists over military efforts.

As Bowles, LeMay, and the leaders of Project RAND shaped the fledgling organization in 1946 and 1947 these cross currents within the Army Air Forces and in the larger political landscape had to be tested and negotiated. Bowles's efforts to set in place his corporate model of the military and society reveal the limits of a strategy to concentrate planning and control in the Air Staff. This strategy was compromised by Bowles's position as a consultant with narrow authority for shaping change and by the strictures American political culture imposed on the challenge of weapons production.

Defining RAND: Spring 1946

With the signing of the Douglas contract in March 1946, Bowles turned his attention away from the project for several months. The focus shifted to starting the organization and initiating a research program. The Douglas staff on the project, headed by Collbohm, working with LeMay, Air Staff Plans, and the AMC, defined the day-to-day activities of implementing the contract. The exploration of guided missile technology, which had motivated the project, dominated the first months of project activity, but not in the way Bowles had hoped. Rather than serve as a model on organizing civilian and military resources in the development of new weapons as well as a rigorous investigation of the technology, the service and the project placed guided missile research in a familiar paradigm: interservice rivalry with the Navy.

Exploiting German V-2 experience, the Navy Bureau of Aeronautics in fall 1945 conducted internal studies on the possibility of an earth satellite and initiated a contract with the California Institute of Technology's Jet Propulsion Laboratory on preliminary design assessments of a suitable rocket. By spring 1946 cutbacks in military research and development budgets dimmed prospects for Navy approval of such an undertaking. Still enthusiastic for the project, the Bureau of Aeronautics sought to enlist the Army Air Forces as a partner in the project in a series of meetings from 7 March, just after the Douglas contract was in place, through 9 April. LeMay and his office had responsibility for considering the Navy proposition. It is not clear whether he discussed this question with Collbohm and the Douglas staff.[7] But by early April LeMay had decided the service would define its own rocket and satellite concepts and would not cooperate with the Navy. The possibilities of guided missiles and the claim that the service's present and future identity were linked to "stratospheric vehicles" had informed the Douglas project from the start. Not surprisingly, LeMay charged Project RAND with developing a detailed counterproposal to the Navy plans as quickly as possible. This work would dominate Project RAND's attention for the next several months. A secret report, "Preliminary Design of a World-Circling Spaceship," published in May 1946, was RAND's first research finding. The study, through an assessment of German and American rocket activity, concluded that a staged rocket vehicle was the most effective means for placing a satellite into orbit. The report estimated that a rocket capable of delivering a 500-pound payload into a 300-mile orbit could be accomplished over five years at a cost of $150 million dollars. As a response to the Navy proposal, the report outlined the possible scientific uses of a satellite, including investigation of the physics of the atmosphere, cosmic rays, astronomy, and meteorology--but also noted the possibility of using the rocket as a "long range

7. According to LeMay's calendar, he met with Collbohm, David Griggs (a physicist who had worked with Bowles's office during the war and was now with Project RAND), and other Douglas staff four times over the period from early March through early April as he considered the Navy proposal. However, the subject of the meetings is not indicated. See File "Daily Activities of General LeMay," Reel 1761, LeMay Papers, Office of Air Force History, Bolling AFB.

missile or for carrying human beings." This report and its sequels would become Project Rand's best known products in later years.[8]

But given the maneuverings by Bowles, Arnold, and Collbohm throughout fall 1945 and early 1946 to define the project as a mechanism to recast relations within the service and among the service, industry, and academia, the satellite study represented a modest beginning. The study did meet some of the expectations for linking the project's research activity with service management. Through the process of research, it established a clear link with parts of the Air Staff, circumventing the AMC's traditional role in evaluating and promoting new technologies. The managerial link between industry and service leadership had been initiated and had come through in an interservice contest with the Navy. But the report itself and its conclusions quickly became part of the interservice jockeying for position in the development of guided missiles and of industrial competition for possible service-sponsored missile development projects. As reflected in the satellite study, the project in its first months embodied both new and old ways of doing business. The cornerstone of Bowles's vision, though, was that the project would serve as a nexus in which to negotiate the interests of the major aircraft firms and service leadership. Through such a process industry and the service would guide research activity and, in turn, draw upon such research in planning and decision making. This kind of organizational relationship had yet to be articulated. In

8. Report SM-11827, "Preliminary Design of an Experimental World-Circling Spaceship," File "452.1, Airplanes, General, 1946-47, Vol. 1," Box 652, Series 1, Record Group 18, NARA.

spring 1946, it was still an open question of who would take the lead and how the relationship would be defined.

Neither Project RAND nor Army Air Forces's leaders invoked the satellite study and the pattern of relations it represented as a finished model, for RAND or for other undertakings. Army Air Forces's Deputy Commander Ira Eaker reiterated the guiding assumptions of Project RAND in a letter to Vannevar Bush in mid April 1946. Eaker sought to help Arthur Raymond, Douglas Aircraft's Vice President for Research and Engineering, hire a director for the project. Frank Collbohm, who had worked closely with Bowles in setting up the contract and who reported to Raymond, was the interim director. Both Raymond and Eaker thought the project required a person with national standing in both scientific and military circles. Their first choice was Lloyd Berkner, a close associate of Bush, who led radar research efforts as a captain in the Navy's Bureau of Aeronautics during the war and had returned to his prewar research position in ionospheric physics at the Carnegie Institute of Washington (CIW), of which Bush was director.[9] Neither Eaker or Raymond set down their reasons for making Berkner their leading candidate, but surely the possibility of gaining Bush's support for the project entered into their evaluation. Bush was still a formidable presence in affairs of the military and science; his support would be advantageous. In pursuing Berkner, Eaker was implicitly asking Bush to bless the project itself.

9. On Berkner's wartime and postwar career see Needell, *Cold War Sciencer*, note 6, chapters 3 and 4.

Eaker's letter to Bush illustrated the very permeable boundary between the service and Douglas on this project. Eaker stated to Bush that he would not "of course...suggest to the Douglas Company the man who should direct this work." But in constructing Project RAND as a part of the Air Staff, Eaker had as much at stake in selecting a capable director as Douglas did and sought to impress upon Bush "directly the importance which I attach to the success of this enterprise." Project RAND was an embodiment of "our new philosophy as to research and development of which this revolutionary contract with Douglas is the initial proof." Echoing Bowles's discussions with Arnold as well as Bowles's policy paper for Eisenhower (then in preparation), Eaker outlined this philosophy:

> We call for no specific product, but rather for study and research in the problems of intercontinental warfare....This is a radical departure from our standard procedure in which my Headquarters staff decides on the need for a specific weapon, translates this into a "military characteristic," and contracts are let on the basis of fairly definite specifications for a given article. We are taking industry and through [it] scientists into active partnership with us on the whole complicated process of planning, research, development, production and utilization of new instrumentalities of air warfare. We realize that only through a united team of Science, Industry, and the Military can we hope to achieve national security.[10]

Eaker continued that the genesis of this new philosophy was the service's successful interaction with Bush's OSRD during the war and, in the aftermath of the war, the absence of a replacement institution. In an unsettled world the service still required "an integrated scientific team...We have learned that science and technology are the very roots of modern war." To fill the void left by the discontinuation of OSRD Eaker offered, "as one important phase of our effort...we are trying to achieve greater efforts from industry by contracts of the Douglas type

10. All quotes from letter from I. Eaker to V. Bush, 12 April 1946, p. 1, Box 280, M. Tuve Papers, Library of Congress.

which permit great freedom of action, and will, we hope, encourage the employment on a full or part-time basis of key scientists whom we cannot induce to serve directly with the Army Air Forces." Like Bowles, Eaker saw modern war as a set of conditions that fundamentally recast the military's place in society. The concept of partnership advanced by Eaker, still vague in details, was considered an indispensable organizing idea in preparing for modern war. The importance of RAND, in addition to its actual work, was, according to Eaker, the "proving of this method of attack on military problems in the post-war era and we hope this project by its success may demonstrate a principle of action which will spread to the whole of our efforts toward national security." By not so subtle implication, Eaker was arguing that RAND was a project in which Berkner would be strategically placed to help shape a new period of civil-military relations. Berkner "could look forward to the continuance of this job so long as the clouds of war still hang over the world"--a state of affairs that Eaker and other service officials saw continuing indefinitely into the future.[11]

Eaker's appeal to Bush had an ironic twist. Eaker's concept of partnership--predicated on a system of contracts under military control to industry and universities--turned the OSRD model on its head. OSRD, as structured and operated by Bush, was an example of a partnership of equals--"equal in authority, funds, prestige." OSRD, not the military, controlled the contracting process. OSRD was an institutional device to provide an autonomous voice for civilian science and, thereby, leverage in its interactions with the military. This concept,

11. All quotes ibid., p. 2.

Bush believed, should be the basis of any postwar arrangements for the federal support of science. Project RAND and Eaker's philosophy subverted Bush's core organizing principle. In writing back to Eaker, Bush dryly noted that Eaker had only presented "one side of the subject." Using his own CIW as an example, Bush asked how, in the postwar years, would the country ensure the vitality of top research centers? After all, such research centers provided in the past war and would provide in the future the knowledge crucial for countering the threats of an enemy. The answer was to maintain, as during the war, a pattern of federal support and governance that would enable CIW and universities to conduct research through the norms, practices, and modes of self-regulation already proven. Bush continued:

> Now if I followed out the philosophy presented to me by representatives of the Douglas Company I would destroy this very thing [the autonomy of private research institutions]. I say destroy it, for if the arguments are sound in one case they will be in many. If commercial companies with their ability to pay several times the salaries received by scientists in universities and scientific institutions set out definitely to pick all the best men out of the universities they can go a long ways. If they are so backed up in doing this by important officers of the Army and Navy the effect will be still greater.[12]

Such practices, Bush feared, would place scientists in institutions (corporations) which operated under different assumptions than the university and divert researchers from the basic investigations necessary for a vigorous level and quality of science. And universities stripped of their best people would wither and cease to be producers of knowledge. Bush, like many other science advocates, subscribed to the view that prior to the war there had been a deficit in scientists and, cor-

12. Letter from V. Bush to I. Eaker, 15 April 1946, p. 1-2, Box 280, M. Tuve Papers, Library of Congress.

respondingly, in research.[13] War had exacerbated this deficit by taking scientists away from their normal laboratory routines and creating new demands for the knowledge generated by research. Eaker's philosophy and efforts like Project RAND might deplete what little scientific capital was left. Bush argued that Eaker and other military leaders should reverse course and "use their influence to the greatest possible extent to maintain in private institutions the strongest staffs possible." If Eaker and others did not, then when another war occurred "we should be without the means of forming the equivalent of OSRD and we would be without the great and beneficial influence that came to our fighting strength because of the presence of strong highly independent scientists in great numbers." But here Bush seems to have missed the point of the sweeping commitment to preparedness advanced by Arnold, Bowles, and now Eaker and which had motivated Project RAND. It was to integrate science and technology into the service on an ongoing basis, so as to obviate the need for another quickly assembled, scientist-controlled OSRD in the future. The service's goal, as suggested by Eaker's position, was to arrange directly for its own needs in science and technology.

Bush's response to Eaker covered another aspect of postwar policy. Insulating the university from the marketplace and from ill-considered military contract practices was only one part of Bush's prescription. The flip side of ensuring a place for independent scientists in their laboratories was to create a role for these scientists in the management of military research and development. As Bush

13. This was one argument advanced for the establishment of a National Research Foundation by Bush and others in 1945-1946. See note 3.

argued months earlier in January before the Woodrum Committee, a structure in which scientists had an independent voice (through equality in funds, prestige, and authority) was basic to his formula for partnership. A secure institutional role for science in the decision-making circles of Washington would ensure proper, centralized control and coordination of industrial and university resources across the nation. Eaker's philosophy and Project RAND might undermine this important objective as well. Bush argued:

> There needs to be a strong scientific staff right here in Washington; in fact, there need to be several. As the Army and Navy now proceed with the extraordinarily difficult problem of the development of scientific leads that were opened up during the war into effective weapons they will need detached advice. It must be advice of the highest caliber, unconnected in any way whatever with either the political or the industrial scene. It must be rendered at the top echelons, and it must be brought to bear on problems of real magnitude."[14]

Bush sought a governing structure for research and development in which science, the military, Congress, and industry were equals. Science, Bush averred, made its distinctive contribution to the war because of professional structures which regulated practices of knowledge generation and relations with governmental, military, and industrial interests and money. The goal of these structures was not the extremes of isolation or dependence, but to ensure that science came to the table as an equal with other powerful institutional, political, and professional interests. Incorporating science into the top echelons of decision making and policy would ensure this balance of interests.

Bush's strong feelings on this issue were present in the concurrent debate on a NRF. In contrast to the Bush-supported NRF, the Truman administration as well

14. Letter from V. Bush to I. Eaker, 15 April 1946, note 12, p. 1-2.

as legislation sponsored by Senator Harvey Kilgore aimed at making the proposed institution more responsive, respectively, to the President and to Congress. Bush's prescription for scientific independence ran counter to established patterns of political accountability in the expenditure of public funds and the making of public policy. His insistence on this position would help delay the foundation legislation for several years. In the spring and summer of 1946, Bush took the same position in debates on unification and on the management of military of research and development through a new JRDB. In these instances, too, he sought an autonomous place for science in the councils of government. Project RAND, representing the distorting influences of industrial money and interests, simply added a new wrinkle, another threat to Bush's organizational objectives.[15]

Bush's letter to Eaker had the air of a rear guard action. While Bush had influence and allies, he had to push vigorously to create the independent position for science he envisioned. But the incentives for many in Congress or the military to adopt or accept Bush's notions of independence were not compelling. Bush, after all, was calling for new practices of bureaucratic and political governance that would infringe on existing prerogatives of Congress, the President, and the military. This call would be at least partially successful in the case of the JRDB, but would fail to establish his version of NRF.[16] Science could be drawn into affairs

15. On Bush's ideas on science and questions of postwar organizations see Kevles, "Scientists, the Military, and Control of Postwar Defense Research...," and Kevles, "The Debate Over Postwar Research...," in note 3, as well as Needell, *Cold War Science*, note 6.

16. Bush's success in establishing the JRDB resulted from a convergence of interests. The Joint Chiefs of Staff also were concerned about the services sprawling and sometimes overlapping research and development efforts in a period of reduced budgets. They also wanted a mechanism in place to connect the science community with the military. The key was to devise a structure which left to the

of state by means other than Bush proposed--especially through the military via contract. Bush concluded his letter to Eaker by saying that "I admit that the Douglas program is important and hence that there are two sides to the question. It is being studied very thoroughly, and Dr. Berkner and I soon are going to have other conferences. However, I felt that since your letter stated principally one side of the question I ought immediately to state the other."[17] Berkner and Bush apparently did not reject the RAND offer. Berkner joined Bush in summer 1946 in running the JRDB. But Douglas's Arthur Raymond continued to court Berkner through early 1947, and Berkner gave modest encouragement to these overtures. The pursuit of Berkner, though, was a subplot to the relationship between Bowles and Bush and the different prescriptions for postwar organization represented by RAND and the JRDB.[18]

Defining RAND: The Douglas Perspective

As Eaker sounded Bush on Project RAND, the Douglas Company pondered over its contract with the Army Air Forces and the opportunities it might offer in the shifting landscape of relations among industry, the military, and universities. The satellite study, urgently requested by LeMay, consumed much of the time of the project's small staff. The study was but one part of the project's proposed

services final authority to initiate and terminate projects. See Needell, *Cold War Science*, note 6.

17. Letter from V. Bush to I. Eaker, 15 April 1946, p. 1-2, note 12.

18. On Raymond's continued interest in Berkner and its relation to RAND and JRDB politics see E.L. Bowles Diary, Box 1, E.L. Bowles Papers, NASM.

scope of work prepared by Bowles and Collbohm in February as part of the finalization of the contract. John Williams, an astronomer turned mathematician who spent most of the war working under Warren Weaver on OSRD's Applied Mathematics Panel and who was now Collbohm's closest adviser, began to think through the implication's RAND's broad mandate to study intercontinental warfare. He sketched a rough map of what such research might include: aircraft, missiles, atomic power and weapons, electronics, and others--an impressive inventory of possibilities. Bowles's and Collbohm's original outline implied a charge to study these different technologies in relation to each other and to possible strategies and circumstances of use. These questions had been more directly broached in the working papers of Bowles and Collbohm from late 1945 and broadened to include questions of military and social organization.

Williams's focus was on defining the question of intercontinental warfare as a research problem: the relevant domain of phenomena, questions to ask, possible methods, and identifying what would count as acceptable products of inquiry.William's reflections centered on the concept of "military worth"--a strategy of inquiry that sought to determine the relative value of one military choice compared to another. Williams's introduction of the concept of "military worth" neatly encapsulated the interpenetration of the new technologies of war with their institutional and political context. Williams soon observed that an assessment of worth might include how far and fast a bomber might fly and the damage it might inflict as well as the resources and cost of producing it, or the changes it might require in military organization, or the incompatibility of a technology or strategy with deeply held national values. Choosing technologies in this domain was an exercise in simultaneously selecting strategies, institutions, and political economies. Military worth suggested a research domain of impressive extent, one in which seemingly well-defined questions of technology merged with the very fabric of the nation's economic and political life. As a mathematician Williams hoped to quantify key aspects of his research domain to allow the meaningful comparisons his concept of military worth invoked. Williams gave rudimentary expression in research terms to the problem Bowles had perceived through the lens of service management and institutional politics: Modern war was a new way of life. The scale and complexity of the technologies and their centrality to national survival were calls to new intellectual explorations and to new modes of social organization.[19]

Williams would develop these ideas, along with others at RAND, over the next few years. The concept of military worth and its successor, systems analysis, would become the dominant organizing concept for Project RAND's activities. These will be considered in the next chapter. Williams's reflections in spring and summer of 1946 were informed by Bowles's ideas and the wide-spread discussion of postwar organization of science, technology, and the military. But Williams's

19. Early expressions of Williams's thinking are J. Williams, "Project RAND," 7 June 1946, RAND Publication D-7, RAND, and "Summary of Conference on Military Worth, 25-26 July 1946, 2 August 1946," RAND Publication D-17, RAND. This later document began the process of identifying the range of professional specialties and specific individuals who might contribute to the definition of the research task. The specialties represented included: history, economics, sociology, logic, law, agriculture, anthropology, demography, geography, political science, physics, statistics, and mathematics.

ideas were too preliminary to add anything to the political issues at hand among Bowles, Eaker, Bush, and others. But Williams's thinking and the expansive sense of possibility it conveyed stimulated Arthur Raymond and Frank Collbohm to consider the organizational implications for Douglas. What might it mean for an industrial organization--a developer and producer of hardware--to be the site of the kind of enterprise Williams was just beginning to articulate? What opportunities did it present for the company as part of the active national discussion on refashioning the connections among science, industry, and the military?

During fall 1945 and early 1946 Bowles and Collbohm had clarified many of the ambiguities in the character of Project RAND and its relation to the Army Air Forces, emphasizing a research and managerial role for the new undertaking and excluding development. But some ambiguity remained on how the project would relate to its parent company. In an attempt to clarify the RAND-Douglas relationship as well as the postwar opportunities offered by the contract, Raymond, in June 1946, drafted a prospectus for a new entity within the company, the Douglas Institute for Advanced Research (DIAR). Paralleling the argument for the proposed National Research Foundation in which support for fundamental science would redound to the benefit of society, the prospectus offered a similar case for the field of "air power and air transport." The future of this field "will be determined by the degree to which scientific research contributes to the solution of broad problems." But it also was a declaration that Douglas and "the aircraft industry must accept a large share of the responsibility for sponsoring, directing, and assimilating research of all kinds which bears on its future problems." DIAR, under Douglas stewardship, would fulfill this need, the prospectus argued. The company would create a new position of Vice President for Research, who would also serve as director of the institute. Raymond, Vice President for Engineering and Collbohm's boss, was to provide "constant counsel" to the new undertaking.[20]

The institute Raymond proposed aimed to fill three roles: to conduct research (in the manner of places such as CIW and the universities that Bush sought to protect) with "complete freedom of inquiry"; to provide Douglas with promising lines of development when research might lead to applications; and to serve as a central site for the industry and the military "to conduct study and research on the broad problems of air power and air transport with the purpose of recommending promising lines of development to be pursued."[21] Not coincidentally, this language was nearly identical to the wording of the RAND contract. Project RAND, of course, would be a major component of the institute. And as Bowles had crafted RAND to serve the ends of revamping the Army Air Forces internal management and its connections to science and technology, Raymond proposed the institute to highlight the different but overlapping needs of Douglas and industry in the postwar period. The institute would both strengthen Douglas capability in research and provide a formal means for coordination and collaboration with other firms and the Army Air Forces. The first end would be accomplished, in part, through extensive part-time consulting agreements with university scientists, who in turn would draw their

20. Prospectus "The Douglas Institute for Advanced Research," p. 1, 6/25/46, Folder "War Effort--RAND Letters, DIAR Prospectus...," Box 1, E.L. Bowles Papers, NASM.

21. Ibid., p. 2.

students into the research interests of the institute. Expecting a keen postwar competition for the time of scientists, the prospectus stated "in this manner [i.e. part-time consulting agreements] science will not neglect fields of endeavor which are part of basic research, but which might be overlooked because of more intense interest in some other field which seemed at the moment more attractive to the scientific fraternity." In particular, the institute through its purpose and programs would ensure that "the future of research in the broad fields of conquest of space and rapid transport in the atmosphere will be more firmly rooted by reason of indoctrination of the scientific profession."[22]

Coordination and collaboration would be accomplished through the use of subcontracts with universities and industrial laboratories. Because DIAR would be the most prominent voice for research on "all phases of air power and air warfare," it "is thus appropriate that it encourage, and, within the limits of possibility, support basic research on these problems throughout the country." In addition, the institute would be active in sponsoring symposia, education programs, and "forums for national discussion" on air power. While military security strictures might limit these outreach efforts, the goal was to engage as wide an audience as possible.[23]

The emphasis of the institute was on laboratory research, and the prospectus called for seven different specialty laboratories. Such research promised to support

22. Ibid., pp 3-4.

23. Ibid., p. 4.

the traditional development and production activities of Douglas and other firms. But also proposed was a "division of analysis and evaluation" to "be composed of scientists, economists, and men of business and other professional experience who are interested in the evaluation of phases of the complex problems of air transport and warfare." This group, as in Williams's nearly contemporaneous reflections on Project RAND's charge, would "deal largely with estimates of the potentialities of various weapons, with basic considerations of the factors influencing causes and courses of war, with the political, social, and economic implications of radical departures in air power and air transport. They will contribute an important part to Project RAND."[24]

By joining more traditional laboratory research with the RAND effort the institute would be better positioned to meet the broader corporate interests of Douglas than Project Rand alone might be. As RAND became defined in early 1946 as a study and research contract, without a development component, the issue of how the project would serve Douglas's long-term interests was unclear. With the institute, Douglas's production activities could benefit from the emphasis on laboratory research, while the "analysis and evaluation" work (focusing on the policy, political, and economic landscape) could help give the company a more influential voice with other firms and with the military. The institute idea also reflected a long-standing tension in the history of the aircraft industry and its relations with the military and other government entities such as the Post Office. This history had been marked by policy shifts and tensions over the role of government

24. Ibid., p. 7

support and regulation, the possibilities of cooperative effort among firms, and self-interested competition.[25] Placing the institute within Douglas suggested a desire for competitive advantage, but the proposal to include other firms recognized the practical virtues of cooperation in a high-risk, difficult business.

But apparently Raymond did not push the institute prospectus. The cost of setting up an extensive laboratory organization was undoubtedly prohibitive as wartime contracts for aircraft ceased. Such a pronounced emphasis on research would have been a sharp departure from the company's past practice.[26] The funds for Project RAND were in hand, it was already underway, and it would have comprised the largest part of the institute. And without a program of laboratory research there was no reason to fold RAND into a company institute. But

25. The best account of the aircraft industry and its relations with the military and the congressional committees controlling military aircraft expenditures is Jacob Vander Meulen, *The Politics of Aircraft: Building an American Military Industry* (Lawrence, KS: University Press of Kansas, 1991). Vander Meulen argues that industry leaders sought to adopt cooperative, associationalist models of organization as part of the Air Corps Act of 1926 and through the New Deal's National Recovery Administration. These attempts, however, were thwarted by congressional military appropriations committees determined to see the industry structured as a competitive market. As the military market constituted the bulk of industry sales, the committees achieved this end through their control over the particulars of contracting regulations. At issue for the committees was whether the industry would be a creature of state planning or of the efforts of individual entrepreneurs in a competitive market. During World War II, the sheer volume and complexity of aircraft production enabled new attempts at cooperation. Manufacturers on the west coast, soon joined by their counterparts in the east, organized the National Aircraft War Production Council for planning and producing the wartime upsurge in new aircraft. On this see Frank J. Taylor and Lawton Wright, *Democracy's Air Arsenal* (New York: Duell Sloan and Pearce, 1947), chapter 3.

26. On research at Douglas prior to and during the war see Arthur Raymond, Oral History Interview, RAND Oral History Project, NASM.

Raymond's reflections on the institute were not idle. The $10 million contract for RAND was a tremendous asset for Douglas in 1946. Douglas's sales plummeted from around $800 million in 1945 to just over $100 million in 1946.[27] Project RAND provided useful, immediate income and, through its research and planning emphases, promised possible leverage in developing new products and markets. Accommodating RAND was a crucial question. The place of RAND in Douglas, its relations to other firms, and to the Army Air Forces would start to come to a head in fall 1946 as Edward Bowles sought to shape RAND to his original vision.

Defining RAND: Symington's Critique

Bowles stayed in the background of Project RAND through spring and summer. During this time he worked on a draft of an "educational program involving military and civilians," started an effort to link commercial transport aviation to the military, worked on the Army Air Forces's problem of establishing an effective world-wide communications system, and continued his involvement in what he called scientific intelligence. Bowles, had been instrumental near war's end in creating the War Department's Field Intelligence Agency, Technical (FIAT), an entity for gathering data on German scientific and technical work for use by British and American military and industries.[28] He was also involved in fledgling efforts

27. Kuhn, Loeb, & Co., "Douglas Aircraft Company, Inc. and the Aircraft Manufacturing Industry," July 1954, p. 98, Folder "Douglas Company, General," Technical Files Collection, NASM.

28. On the educational program see letter from Bowles to Patterson, 3 June 1946, Folder "War Effort--ELB and Associates...R.P. Patterson," Box 4, E.L. Bowles Papers, NASM. On communications see, for example, letter from Bowles to Major General H.A. Craig, 6 August 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, LOC. On the other points see letter from Bowles to Patterson, 5 May 1947, Folder "War Effort--ELB and Associates...R.P. Patterson," Box 4, E.L. Bowles Papers, NASM.

in 1946 to build up a scientific evaluation function in the State Department. He prepared two more statements of his position on science, technology, and the military. "National Security and a Mechanism for its Achievement," published in May 1946 under the auspices of the Institute of Radio Engineers, was a brief follow-on to the Eisenhower policy paper.[29] Over the summer Bowles gave his attention to preparing a speech for the now retired Arnold to presented at the Institute of Aeronautical Sciences, one of the primary professional associations for engineers in the aviation field. Typically, Bowles solicited the assignment from Arnold, viewing it as a crucial opportunity to provide a statement of policy for the Army Air Forces, incorporating the meaning of his war experience and all his efforts of the past year.[30] The speech, Bowles hoped, would set forth the policy and direction for science and technology in the postwar service as the Eisenhower paper had tried to do for the War Department. But here Bowles would not have to filter the speech through the Air Staff; he and Arnold would determine the content.

29. Bowles's goal in this paper was to address his fellow engineers on the postwar situation, its meaning for the profession, and their social responsibilities. Edward L. Bowles, "National Security and a Mechanism for Its Achievement," *Proceedings of the I.R.E. and Waves and Electrons* April (1946).

30. Arthur Raymond, Douglas Vice President for Engineering and the company's principal on the RAND contract, was president of the IAS and extended the speech invitation to Arnold--another marker of the interpenetrating connections among the service, industry, and professional associations at the time. See letter from A.E. Raymond to Arnold, 10 April 1946, Folder "#4 (Speeches and Writings 1946), Box 237, Arnold Papers, Library of Congress.

Arnold delivered the speech, with the unsurprising title "The Past Predicts the Future," in mid July 1946.[31] Bowles's text followed the main points of his work on Eisenhower's "Scientific and Technological Resources as Military Assets," linking together the themes of preparedness; innovation through science and technology; integrating universities, industry, and the military (especially through collaboration in long-range planning); and inculcating a sense of personal responsibility for the social burdens of modern war through programs of education in the services and at universities. Many of the specific examples deleted from the earlier paper were included and amplified--such as the wartime B-29 modification project that had formed the network of relationships leading to Project RAND. RAND was discussed only in general terms because the project itself (not just some of its work) was classified at the time.

The speech advanced one new need of the postwar period absent from the Eisenhower paper: operations research. In 1943 Bowles had been a central figure in one of the most celebrated successes of operations research during the war, instituting counter-tactics to lessen the impact of German U-boat attacks on Allied transport traffic in the Atlantic. But during and after the war Bowles's interest was not in the analytic techniques or the professionalization of the new field. He saw operations research as a supporting element in the postwar refashioning engendered by new relations among science, technology, and warfare. Operations research was a tool for military managers to enhance rational decision making in integrating

31. Speech "The Past Predicts the Future," 19 July 1946, Folder "PWP--"The Past Predicts the Future," Box 1, E.L. Bowles Papers, NASM.

civilian scientific and technological resources with the service. Managerial and political ends were primary; operations research was an instrument to help achieve those ends.[32] All of these points were then set into the broader context of postwar policy--unification and the establishment of the United Nations. These were special interests of Arnold's, who saw in both these developments the opportunity to secure a preeminent role for air power in the military establishment and in maintaining stability internationally in the unsettled postwar world.

But the most noteworthy aspect of the speech was that Bowles had to work through Arnold, respected and revered but retired and outside the inner circle of decision-making. This fact captured Bowles's weaknesses and strengths in summer 1946. Bowles's aim of creating a common language and framework of examples to guide service policy and thinking would undoubtedly have been more effectively implemented if he had worked through Commanding General Spaatz, Eaker, LeMay or through Secretary Symington. But Bowles's relationships within the service, with perhaps the exception of LeMay, did not enable him to speak through these other leaders. Bowles, though, played his strengths. Writing to Arnold after the 19 July speech, Bowles stated he was "systematically selecting individuals to whom to send your speech in order that it may be developed into a policy paper.

32. Discussion on operations research in ibid., pp. 5-6. "It seems to be me we must do something to encourage greater interest in the application of scientific reasoning to the evaluation of problems which deal not alone with machines, but with the integrated combination of men and machines." It should be noted that Bowles's contributions to the wartime U-boat menace were not technical but organizational--finding new organizational mechanisms to overcome the intense interservice rivalry between the Navy and Army Air Forces in marshaling a response to the attack on Allied shipping. This is consistent with his focus on managing technology to suit institutional goals.

...Also, I am going to discuss the paper with Secretary Symington in the hope that he pass it down the line with a benediction."[33] And this Bowles did. He met first with Commanding General Spaatz, pointing out "the background, objectives, and potentialities" of the Arnold address. Spaatz "gave it his endorsement by having it circulated throughout the Air Forces." Bowles met with Symington with the same results. Symington "read the speech immediately and was obviously very pleased that you had given it. When I left his office he was on his way to see Tooey [Spaatz] to indicate the importance of bringing your paper before the Air Forces as a whole. As it happened, Tooey had already been posted and taken action."[34]

But despite Symington's apparent enthusiasm for the speech he found Bowles's perspective difficult to grasp. While Symington praised Bowles's speech writing for Arnold, he was perplexed by the document in which Bowles most completely articulated his ideas for postwar organization: Eisenhower's "Scientific and Technological Resources as Military Assets." On 23 August Symington wrote to Bowles saying he had "read and reread" the Eisenhower memorandum of last April "in order to understand more clearly the thinking." He asked Bowles to clarify each of the five major points of the policy statement on research and development. All the questions touched on the basic assumption of Bowles's position--as expressed in the Eisenhower paper, the RAND contract, and all his postwar work: The character of modern war and of producing modern weapons in the American

33. Letter from Bowles to Arnold, 13 August 1946, Folder "War Effort--ELB Associates...ELB and H.H. Arnold," Box 4, E.L. Bowles Papers, NASM.

34. Letter from Bowles to Arnold, 27 August 1946, Folder "War Effort--ELB Associates...ELB and H.H. Arnold," Box 4, E.L. Bowles Papers, NASM.

context required new organizational and political strategies for linking industry and universities in the private sector with the military. Traditional modes of contract procurement and of interest group politics were insufficient tools for military managers charged with preparing for the new warfare. Symington found it difficult to envision how the "close integration of civilian talent with military plans and development" would be implemented. Would civilians be placed into the "operating line of research and development" and given authority? And within the Army, would new Director of Research and Development Major General A.S. Aurand, in a reversal of wartime practice, have "line authority control over the Research and Development of such a component branch of the War Department as the Air Forces; and if not complete authority, how far does the authority go? Could you be specific on this?"[35]

Symington's letter indicated Bowles's failure to involve fully the Secretary in his reform efforts. In the spring he had tried to interest Symington in the Eisenhower policy paper and in its opportunities for the service, but had not followed through with the Secretary after Eisenhower created the new post of Director, Research and Development Division, and made Bowles's paper its charter. Symington's concern over the new post was sparked by a discussion with Aurand in mid August.[36] In the months before, Aurand had given indications of making

35. Memo from Symington to Bowles, 23 August 1946, Folder "Scientific and Technological Resources as Military Assets," Box 2, E.L. Bowles Papers, MASM.

36. See memo from Aurand to Symington, 14 August 1946, Folder "Scientific and Technological Resources as Military Assets," Box 2, E.L. Bowles Papers, NASM.

the office a vigorous exponent of Army support for research and development.[37] Bowles, though, had distanced himself from the office he had helped create. He was disenchanted with Aurand, whom he felt had poor credentials for the post, and with Eisenhower's decision to position the office at the same level as other Army staff functions. The result, in Bowles's view, was not as satisfactory as his reorganization efforts within the Air Force, with LeMay managing research and development issues as the Air Staff's third-in-command. Moreover, Bowles preferred the company of the professional military and never established a comfortable working relationship with Symington.

Bowles delayed responding to Symington until the Secretary prompted him a month later with a reminder memorandum. In early October Bowles responded with twelve pages of explanation supplemented by eleven appended items. Bowles's extended response to Symington revisited his arguments on the necessary consequence of preparedness: researching, developing, and procuring weapons required new organizational forms joining the civilian and the military. On the sometimes elusive concept of integration, Bowles offered:

37. See for example Aurand's address to the Engineers Joint Council, 26 July 1946, JRDB 22/1, Box 18, Entry 341, RG 330, NARA. The occasion was to honor Lawrence and the invention of the cyclotron. After an introductory appreciation of Lawrence and of the assembled scientists and engineers, Aurand offered: "Our program is, and must continue to be, one for preparedness; and it is your job and mine to see to it that we do not lag behind any possible enemy. ...The Office of Scientific Research and Development...is in the process of demobilization and is taking no new problems. Its permanent alter-ego, the National Science Foundation, has not yet been legislated into existence. It is necessary for the research and engineering of the armed forces to continue during this interim period. So the publicly owned laboratories and drafting rooms, as well as the research and engineering staffs of our educational institutions, industries and foundations, are being put to work in as orderly manner as possible by the research and engineering agencies of the War and Navy Departments."

> What I had in mind was that currently and during the war there was a preponderant opinion that civilian assistance, particularly of the sort we were given through OSRD, was mainly proficient in the development of weapons. Moreover, in the technical services there was predominantly the philosophy that the civilian assistance from our industry was primarily for the purpose of producing weapons. We were not at all effective in using civilian assistance in planning itself. This operation was for the most part deemed sacrosanct and was a high privilege of a staff planning body surrounded with an aura of security. In order to integrate our military, scientific, and industrial resources effectively I did my best in the areas of my responsibility to break down this fetish.[38]

Bowles illustrated this general proposition with his usual impressive list of examples: the 1944 B-29 project with Douglas, the RAND contract, the LeMay post, the Aurand post, and the Eisenhower paper.

But Bowles had some difficulty in directly addressing Symington's practical questions on lines of authority. As Symington correctly perceived, the two devices Bowles relied on to effect integration--the contract and the establishment of top level staff positions for research and development--were weak tools for breaking down old practices, building up new ones, *and* concentrating authority at the top of military organization. The top-down managerial vision Bowles advocated and Eisenhower legitimated as policy seemed to require a clear exercise of authority for implementation. How could contracts and top-level staff positions result in integration of civilian and military resources directed by military managers? A contract for planning assistance, let by the service, would be an anomalous instrument for achieving this end. It might strengthen Air Staff managerial capabilities but also might interpose private civilian authority over some part of the military.

38. Memo from Bowles to Symington, 2 October 1946, p. 1, Folder "Scientific and Technological Resources as Military Assets," Box 2, E.L. Bowles Papers, NASM.

Bowles offered that the latter possibility was not the intent of such contracts, including RAND. "We do not cut civilians into the operating line of research and development through the Army but use them on location in industry or educational institutions by means of contract."[39] In the case of RAND, by the letter of its contract, this was correct. But as an adjunct of the Air Staff, Bowles intended the project to provide an alternate, more authoritative voice on research and development matters in place of the AMC. Through RAND and the LeMay post Bowles sought a means for managing the work of the Command.

Likewise, Bowles explained to Symington that the Aurand post did not have line authority over the Army Air Forces or the Army's research and development activities in operating units such as Ordnance or the Signal Corps. As with other positions on the War Department General Staff, it set goals, policy, and standards that guided the work of operating commands. How then might top leadership assure the integration and enhanced coordination of military, industry, and university research and development work? Bowles's answer was sociological: civilians and military professionals shared a common outlook on preparedness and as rational managers would cooperate toward the common end of ensuring national security. In the case of RAND, Bowles stated, "I believe this new type of contracting, in which the contractee's top staff has recourse to our top staff, will do much to establish mutual confidence at a level essential to our effective use of our industrial resources. Furthermore, this technique should actually serve to bring

39. Ibid., p. 8. This quote also highlights another aspect of Bowles's concept of integration: in addition to enhancing managerial coherence in organizing research and development, it was designed to extend the service's geographical reach.

our own Materiel and Planning people closer together."[40] The same would hold true for Aurand's Research and Development Division. Bowles argued that building this climate of cooperation would be a crucial responsibility of the incumbent of the new General Staff office:

> The greatest attribute he can have is that intangible strength which will come from the kind of administrative effort which will require cooperation rather than separation...and create the kind of confidence that would come from a broadening throughout the Army of our cooperative relationships with industrial, scientific, and educational resources. As I visualized this new office, I had in mind that it would be the means for drawing together in the interest of national security the greater team effort that is made up not of the Army alone, or industry alone, or our educational areas alone, but of a closely knit combination of these three great assets.[41]

Bowles also argued that in addition to helping the Army, Army Air Forces, and the country confront the problems of the postwar period, these organizational innovations were crucial in competing with the Navy and to have a strong representation in the newly created JRDB. "The Eisenhower policy paper," Bowles said,"must be interpreted in light of the charter of the new Joint Research and Development Board....The board acting through the Secretaries is a powerful agency. Its value to the Army and Air Forces will be enhanced by strong comprehending administration within our own family."[42] Bowles, of course, had already played a central role in creating the organizational structures which could make this possible. But as RAND developed in its first months Bowles would discover how difficult it would prove to implement his concept of integration through contracts, military organizational inventions, and a community of shared interests.

40. Ibid., p. 3.

41. Ibid., p. 11.

42. Ibid., p. 12.

Defining RAND: Organizing Industry and the Associationalist Model

In early August, Wellwood Beall, Boeing's vice president, engineering and sales, wrote to Bowles asking how much time Clair Egtvedt, the company's chair of the board of directors, would need to give to Project RAND. Donald Douglas and Arthur Raymond previously had apprised the Boeing president and Jack Northrup, president of Northrup Aircraft Co., of the new project and, probably at Bowles's encouragement, invited their participation--but without specifics. Bowles had just met with Raymond, who had promised to draw the other companies into the project. Bowles promised Beall that Raymond would be in touch soon.[43] In early September, frustrated by Donald Douglas's and Raymond's lack of progress in organizing their industry colleagues, Bowles wrote to Arnold. The letter was a measure of Bowles's still strong ties to Arnold and of the absence of a similar close relationship to present military leaders. This plea to Arnold also revealed the fragility of Bowles's expectation of a cooperative managerial venture between the service and Douglas. Bowles sought Arnold's help in moving Douglas to keep his original commitment to the project. Bowles lamented, "Now that all the obstacles within the military have been overcome, it looks as though the real obstacles are within the Douglas Company itself."[44]

43. See letter from Bowles to Beall, 13 August 1946, Folder "W.E.--RAND, Aug-Sept. 1946, Correspondence with W. Beall," Box 2, E.L. Bowles Papers, NASM.

44. Letter from E. Bowles to H. Arnold, 5 September 1946, p. 1, Folder "War Effort--RAND Letters, 1944-03/48," Box 1, E.L. Bowles Papers, NASM.

Donald Douglas, Bowles felt, was not approaching the project in the right spirit. Bowles had encouraged the placement of the contract with the company because Douglas had led him to believe that "having had the satisfaction of building a great organization and of making a handsome contribution to aviation [he] was now ready to go forward to bigger things." In early summer, Douglas and Raymond conveyed to Bowles the idea of the DIAR, and Bowles thought this "foundation to underwrite outstanding research in aviation" would meet the spirit of RAND and show Douglas as an industrial statesman. Bowles went on: "Since that time, I have got the distinct impression that this idealism has vanished from the picture and that we are working with Douglas on a strictly business basis, in which the Army Air Forces are underwriting any and all expenses of this project except what the Douglas Company may come by through taking over war assets."[45] Douglas had displayed "too much of a tendency...to monopolize the project" by not yet including Boeing and Northrup.[46]

Moreover, Douglas's slowness in helping to fulfill the managerial objectives that were so dear to Bowles endangered the project. Bowles was ill-positioned, as his reliance on Arnold's help indicated, to hold together the still fresh consensus on the RAND type of contract and on the consolidation of decision-making authority on research and development in the Air Staff as represented by the LeMay post. He noted to Arnold, "the opposition [the AMC and possibly even Symington] is sitting by, if I may say so, gloating over the impending failure of what they con-

45. Ibid., p. 5.

46. Ibid., p. 3.

sider an unrealistic and ill-conceived enterprise."[47] Bowles wanted Douglas to appoint Raymond, rather than Frank Collbohm, to manage actively the project. "...Unless Douglas is willing to put a man like Raymond on this project full time--and I mean full time--until its success is assured, it is going to bode ill for the Air Forces and for the country in general. It is my conviction that if we are to make the most of our industrial talent and potential we must preserve this pattern of cooperation...."[48]

A few days later Wellwood Beall traveled to the Douglas Company in Santa Monica to discuss with Raymond, Collbohm, and Gene Root (one of Douglas's leading engineers) Boeing's participation in RAND. Again, Beall was disappointed. The Douglas group offered Boeing a subcontract to study the range of possible bomber technologies for conducting intercontinental warfare.[49] According to Bowles, Beall "felt that Douglas was getting too much into details and not enough into the broad subject of the Douglas contract...." Such an approach, Beall conveyed to Bowles, "would never get for the Air Forces the benefit of superior

47. Ibid., p. 2.

48. Ibid.

49. In addition to studying the missile and satellite question, RAND had also started an assessment of intercontinental warfare using bombers. Douglas was proposing to contract part of this work to Boeing. This work began RAND's connection to the Manhattan Engineer District and later the Atomic Energy Commission. See for example RAND's request for "the minimum rectangle which will enclose the latest type atomic bomb." Letter J.R. Goldstein to Commanding General, MED, 5 September 1946, File "161 Contracts, 1946-47, Vol. 2," Box 573, Series 1, RG 18, NARA.

staff thinking available in Boeing."[50] Participation via subcontract would be no inducement for Boeing board chair Clair Egtvedt to take an active role in the project. Beall's suggestion was for Bowles to push a completely separate contract for Boeing. Bowles apprised Arnold of the situation, noting "only if a company like Boeing has the same opportunities as Douglas to cooperate directly with the Air Force Plans people will we ever achieve the ideal you and I visualized."[51] But reaching that ideal would not be through a multiplication of contracts; the funds did not exist for a Boeing version of RAND. Nor would such a move be desirable; Bowles's goal was to concentrate managerial expertise not to disperse it.

As Bowles often pointed out, the establishment of an ongoing, formal relationship between industry and service leadership--through which classified, closely-held planning information was shared--was a sharp departure from past practice. As part of the project, Douglas and the Army Air Forces had already begun this arrangement by summer 1946. In mid September another exchange occurred in which the Air Staff briefed "the Douglas representatives on the current strategic concepts and the intelligence estimates of the world situation."[52] While no research, development, or production contracts came out of such meetings, they clearly provided a forum for establishing cordial and close working relationships

50. Bowles Memo to File, 11 September 1946, Folder "W.E.--RAND, Aug-Sept. 1946, Correspondence with W. Beall," Box 2, E.L. Bowles Papers, NASM.

51. Letter from E. Bowles to H. Arnold, 11 September 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

52. See memo from DC/AS RD to AC/AS-2, 14 August 1946, File "380 Projects, 1946-47, Vol. 2," Box 639, Series 1, RG 18, NARA.

with service leadership, unavailable to other companies. Boeing's desire to be an equal participant in RAND or have its own similar contract was understandable.

Bowles, with Arnold's help, began to craft an overarching management structure for RAND that would involve several companies rather than just Douglas. Arnold did not get back to Bowles until early October, promising to "take the matter up with [Donald] Douglas at the first opportunity...it must be straightened out without delay."[53] In late October, Raymond met with Bowles in Washington. Bowles "had a very strong talk with Raymond" and confided in Arnold that "between LeMay and myself we have built a fire under the Douglas organization that will heat them up a bit and bring results."[54]

To "make sure of the right kind of progress" LeMay and Bowles traveled west in early November and met in Seattle first with Boeing leaders and those of Northrup, Douglas, and North American in Los Angeles. The last company, headed by Dutch Kindelberger and Lee Atwood, had not yet been part of project discussions and, as one of the leading aircraft firms, Bowles wanted their participation too. At Boeing, Clair Egtvedt, William Allen, and Beall, were "all entirely sold on the philosophy of Project RAND and want to participate. All they were waiting for was a call from Mr. Douglas to bring them together to discuss how

53. Letter from H. Arnold to E. Bowles, 2 October 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

54. Letter from E. Bowles to H. Arnold, 1 November 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

they could best contribute." Of Northrup, Bowles wrote to Arnold, "to me he [Northrup] is a highlight, for, of all the group, he is the most understanding..." Kindelberger and Atwood needed a little more persuading. "Atwood was a bit hard-boiled and materialistic at first....Later, when Dutch joined us the atmosphere cleared a bit. Dutch got out of his system what was bothering him, and it was the Douglas approach. I can't remember his exact words but the context was to the effect that if you want to solicit the interest of the boss man you don't send the janitor around for the purpose."[55] Kindelberger was miffed that he had learned about RAND through Collbohm and not through Douglas or LeMay. Bowles and LeMay next convinced Donald Douglas to form a "governing council" composed of the presidents of the four companies.[56] They pushed Douglas to call the other companies and determine "a method of operation whereby these several heads would determine the policies and programs for the direction of the effort in behalf of Project RAND."[57] In late November Douglas, perhaps stung by Bowles's criticisms as well as by LeMay's sway over service present and future contracts to

55. Letter from Bowles to Arnold, 15 November 1946, p. 1, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

56. One of Bowles's first actions on returning from the trip was to inform Secretary of War Patterson. See letter frm Bowles to Patterson, 7 November 1946, File "Atomic Energy, Safe File #3," Series "Former #75," RG 107, NARA. But the purpose was less to convey information about RAND than to ask Patterson to intervene with General Groves for a Manhattan Engineer District security clearance. The question of atomic energy had been closely intertwined with the project from the beginning--both in terms of aircraft design and applications to propulsion. The Douglas staff had been interested in this question all along and presumably it arose as part of the discussions with the other companies as well. Bowles wanted clearance to facilitate the work of the project and expand his sphere of expertise with Patterson. Patterson agreed, but it seems Groves never granted the clearance.

57. Letter from Bowles to Arnold, 15 November 1946, note 55, p.1.

the company, formed the council.

With LeMay's and Arnold's leverage, Bowles had at last stimulated Douglas to participate in his vision of the project as an exercise in associationalist cooperation--of the military and aircraft industry mutually organizing to meet the perceived requirements of modern war. This cooperation was not explicitly called for or implied by the RAND contract or by the inventions of the LeMay and Aurand posts for directing research and development from the top of the Army Air Forces and the War Department, respectively. In a political and military bureaucratic culture in which centralized planning of industry through the military or direct state control was resisted, this cooperation was a matter of persuasion and shared interests. Bowles, temporarily, won the day.

Bowles, though, felt Douglas should have taken this step months before. Because "the approaches were made in the lower echelons, an understanding of the ideals of the project had not been got over. The feeling was prevalent that the Douglas Company was simply using the other aircraft companies to work on details."[58] As a result of the trip, Bowles and LeMay demonstrated to these companies that "Commanding General Spaatz and the Air Forces...want their direct participation not only in the project, but in our Air Forces planning." As with Douglas, officials at Boeing, Northrup, and North American would brief and be briefed by Air Force Plans, "thus ensuring integrated effort." Bowles suggested to Arnold that the next step should be to bring the governing council to Washington

58. Ibid.

to have them meet with Spaatz, LeMay, Eisenhower, Aurand, other generals, and "perhaps injecting Dr. Bush to let him see that we are on our toes. I believe that some such step would do a lot to get them all steamed up and completely committed to the idea that this is a unique program with the Army completely behind it."[59] Arnold reinforced the efforts of Bowles and LeMay by talking with Don Douglas and Arthur Raymond, Kindelberger, Northrup, and broaching the RAND idea with the Lockheed Company. After reading RAND's second quarterly report in fall 1946, Arnold, too, was dismayed at RAND's progress and was convinced of the necessity of Bowles's recent steps. Writing to Bowles, Arnold now was "of the same opinion you hold: the situation calls for a little dynamite."[60]

The Associationalist Model: Symington's Caution

But before Bowles could savor his accomplishment and organize the Washington meeting, Symington temporarily dampened his exuberance. Bowles had involved Arnold and LeMay and informed Patterson, but it seems he had not made the effort to keep Symington aware of the fall's events. Bowles's uneasy relationship with the secretary seems to have been the reason. In late November Symington wrote Bowles, again asking him to explain one of his major initiatives--this time Project RAND. Symington shifted from questions on Bowles's rhetoric of integration to citing specific problems regarding RAND that had been brought to his attention. Companies in the aircraft industry, which Symington did not

59. Ibid., p. 2.

60. Letter from H. Arnold to E. Bowles, 3 December 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

specify, were "protesting the nature of the RAND project contract with Douglas. They [the companies] say it gives Douglas a long start, if not a monopoly, in this field, on a non-competitive basis under which they cannot lose money."[61] The concern was over the advantages that Douglas might gain from the missile and aircraft research done under the RAND contract as well as the intimacy of the working relationship with the Air Staff. Talk of integration might be fine, but Symington, as Secretary, saw his first responsibility as upholding well-established contract practices and as heading off political problems with Congress and the press.

Even before the industry complaints, Symington's impressions of RAND came not from Bowles but from RAND reports which were directly distributed to him--and his impressions were not entirely favorable. In May, on the possible implementation of one aspect of the satellite study, he wrote to Deputy Commander Eaker, "it looks to me as if we will be sticking our neck out as regards careless use of taxpayer's money, but whatever you say is alright with me."[62] Later, in early November, after reading RAND's two first quarterly reports, he again noted to Eaker, "they are very interesting and over my head. I hope we are getting our money's worth."[63] With this as background, Symington wanted to

61. Memo from S. Symington to E. Bowles, 22 November 1946, File "160 Contracts, 1947 Decimal Files," Series "Former" #40, RG 107, NARA.

62. Memo from S. Symington to I. Eaker, 13 May 1946, Folder "470, 1946, Security Classified Correspondence," Series "Former" #39, RG 107, NARA. The specific proposal, never undertaken, was to send an uninstrumented projectile to impact on the moon. From the perspective of his office, Symington was justifiably skeptical.

63. Memo from S. Symington to I. Eaker, 9 November 1946, File "160 Contracts, 1947 Decimal Files," Series "Former" #40, RG 107, NARA.

know the history of the project, Arnold's and Bowles's roles, and the present status.

Symington's note to Bowles touched an institutional sore spot. In late 1945 and early 1946, Bowles and Arnold had raised the question of which elements of the service would control the varied aspects of research and development--their direction, definition, the relations with industry and universities, and the contracting process. Bowles's and Arnold's answer was to establish the LeMay post and the RAND contract and make the Air Staff the locus of most decision-making, curtailing the traditional influence of the AMC. But this institutional agreement still met substantial resistance. Symington's questions regarding RAND, hinting of a political and public relations problem, were an opportunity to revisit the earlier agreements. For the AMC the memo was both a catalyst and opening to undo these understandings; for LeMay and Bowles the memo was a call to defend them.

LeMay responded first. He echoed, with less fervor, the language of Bowles on the need to break down the twin "fetishes" of excluding civilians from military planning and of the AMC practice of contracting for specific products when research and advice were called for. LeMay noted that because the RAND "type of contract was progressive and different from anything that had ever been done before, there was some objection to it in the Air Materiel Command."[64] Despite AMC reservations, LeMay went on, the contract was working, attracting scientists

64. Memo from C. LeMay to S. Symington, 22 November 1946, p. 1, File "160 Contracts, 1947 Decimal Files," Series "Former" #40, RG 107, NARA.

to military research and establishing a pattern of cooperation in military planning in the Air Staff. As a departure from past practices in working with the industry, this new pattern of cooperation--unspecified in the RAND contract and relying on a shared sense of postwar organization--was bound to encounter difficulties in implementation.

The primary criticism, as first expressed by Boeing in September, was access to Air Staff planners and the information such contact could provide. LeMay pointed out that his and Bowles's efforts to redirect the project over the past two months would largely address the criticism: "To avoid this type of criticism, it is planned to have RAND administered by the aeronautical industry rather than by one aircraft manufacturer."[65] Everyone would participate and gain the benefits of the new cooperation. But while LeMay and Bowles sought this result they could not and would not order it. It had to be voluntary, albeit induced through persuasion and the incentive of participating in RAND. LeMay pointedly noted "Mr. Douglas would personally call a meeting of Boeing, North American, and Northrup to work out the details of how the aeronautical industry would administer the RAND contract. I personally refrained from offering any suggestions. In fact, I definitely stated that the Air Forces wanted the solution of this problem to come from the industry."[66] The solution was already decided on. Douglas would organize what was now called a "board of directors," drawn from the leadership of the four companies. Other companies would be added "as fast as they can make a

65. Ibid., p. 2.

66. Ibid., p. 3.

contribution to the RAND project. When this is done we will have strengthened our partnership with science and eliminated all cause for any criticism of the RAND project."[67]

LeMay's response to Symington was slanted toward the practical--was the contract working, could the criticisms be addressed? These were the immediate issues which most concerned Symington. Lacking, though, was Bowles's ideological ardor to establish the relationships which LeMay and Bowles were trying to secure through RAND. These were the focus of Bowles's response. Criticisms from industry were shortsighted, he felt, resulting from a lack of appreciation of the larger objective. RAND was an important accomplishment, Bowles argued, and "was being expanded as rapidly as its highly specialized and difficult character will permit, and I believe there can be little criticism of this philosophy."[68] Those companies already in the fold:

> agree that the undertaking has tremendous potentialities in that it will bring the Air Forces and the air industry together and will effect the maximum economy in carrying out our future long-range air research program....This means that we have a mechanism for bringing the top air command or management into cooperation with industry management not simply on materiel issues but on the over-all aspects of air planning for the nation. In this way we will engender the mutual cooperation and confidence which are essential if we are to integrate our natural resources."[69]

Specifically, the industry board of directors for RAND, already described by LeMay, would be the means for organizing industry's contribution and would be

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67. Ibid.

68. Memo from E. Bowles to S. Symington, 26 November 1946, p. 6, File "160 Contracts, 1947 Decimal Files," Series "Former" #40, RG 107, NARA.

69. Ibid., p. 5.

"responsible to the Air Forces for the overall planning and prosecution of the RAND program."[70] Bowles reminded Symington again that RAND was a concrete instance of the philosophy expressed in Eisenhower's "Scientific and Technological Resources as Military Assets." The proper organization of research and development, he had argued, was the most pressing issue in the postwar period for the military. It was, moreover, a national issue, calling for a broad vision. And the Army Air Forces, in Bowles's modest estimation--through his, Arnold's, and LeMay's efforts--was at the forefront of innovation: "The progressive and novel philosophy of the RAND undertaking has, insofar as I am aware, no counterpart elsewhere in the Army or Navy. With support from the industry and the Air Forces it can be the biggest step forward toward integration of resources for security growing out of the war."[71]

Oddly, neither LeMay nor Bowles addressed the issue of just how the industry board of directors for RAND would be responsible to the Army Air Forces. It wasn't a stipulation of the RAND contract, nor did they or anyone else contemplate amending the agreement. Bowles was the only one to identify a structural connection--and it was sociological, a thin ligament of "mutual cooperation and confidence." Perhaps Symington had this problem in mind when in early December he asked to see a copy of the contract.[72]

70. Ibid., p. 4.

71. Ibid., p. 6.

72. Memo from E. Bowles to Brackley Shaw, 12 December 1946, File "160 Contracts, 1947 Decimal Files," Series "Former" #40, RG 107, NARA.

Fortunately for LeMay and Bowles, Symington did not solicit dissenting views on RAND from the Air Staff's Assistant Chief of Staff, Materiel, E.M. Powers, and the AMC until mid December. Their perspectives would not reach Symington until the end of the month. Powers, in his comments to Symington, hit on a crucial point minimized by Bowles: What did the professional military want out of its relations with universities and industry, and who would control actions presumably taken on behalf of the military under contracts such as RAND? Powers described "two schools of thought" prevailing in the War Department and Air Staff--one advocating an open relationship with civilian communities, with minimal contractual and administrative controls, the other calling for less liberality and more controls. Powers was "concerned with the possibility that the military services are granting contracts to scientific groups and educational institutions in accordance with the desires of those concerns rather than the needs or desires of the military services." The loosening in accounting methods and administrative controls that RAND represented might fail to "result in a reasonable return to the military services for the money expended." If they were not careful this situation could "react to the disadvantage of the military services through an impression being gained by the public that the military are spending their money without adequate control."[73]

73. Ibid. Powers had more specific concerns about RAND, particularly the way in which the project interposed itself in research and development decision making. Powers objection was "that the initial concept of operations of RAND...would have required the Air Materiel Command to check with RAND prior to initiation of AMC projects...instead of the reverse procedure." This, of course, was what Bowles and, to some extent, LeMay had sought to do.

Powers was not advocating Bowles-style integration featuring a more direct, rigorous management. His position was to eliminate the RAND-type of contract that allowed this amorphous managerial relationship between Douglas and the Air Staff and that had no defined end product. He wanted, in short, the status quo prior to the changes of late 1945 and early 1946. But Powers's points were valid and, in weaving the issues of proper expenditure of funds and public reaction into his critique, he was speaking a language Symington understood. By the end of December, though, Symington seems to have deferred to the perspectives of LeMay, Arnold, and Bowles. This was probably due less to the force of their arguments than to the fact the industry criticism had subsided.[74] By then Don Douglas had already convened the new board of directors for RAND, quieted the rumblings of Boeing and North American, and Bowles had begun planning his convention of military and industry leaders.

The Associationalist Vision, Seen and Lost

On 12 December Don Douglas led the first meeting of what was now called the RAND Advisory Council. Jack Northrup of Northrup, C.L. Egtvedt of

74. Also a factor was the consideration that the letting of the RAND contract in March 1946 was regarded as a command decision of Commanding General Spaatz. Through the war civilian secretaries rarely questioned or countermanded such military decisions. The difficulty in the postwar period was that the scope of command decisions regularly embraced areas of domestic policy uncommon before the war. On the RAND contract as a command decision see memo from T.A. Sims to S. Symington, 31 December 1946, Folder "160 Contracts, 1947 Decimal File," Series "Former" #40, RG 107, NARA. On the relative scope and balance of authority between military leadership and civilian secretaries during and in the decade after the war see Samuel P. Huntington, *The Soldier and the State: The Theory and Politics of Civil-Military Relations* (Cambridge, MA: Harvard University Press, 1964), chapters 12 and 13.

Boeing, Dutch Kindelberger of North American, and Arthur Raymond were present.[75] Raymond addressed the meeting, summarizing the motivations for RAND and the work underway. As had Arnold and Bowles previously, Raymond located the motivation for the project in the need for preparedness and in the intimate, ongoing links between private industry and the military such readiness implied. Raymond reflected on the special meaning of RAND for the industry in this climate of preparedness. The context, understood by Raymond and his audience, was the distinctive relationship the industry had with the military in the 1920s and 1930s. The military had been the industry's major market. Yet contracting regulations imposed by Congress made the relationship unprofitable for many firms. Firms invested resources in experimental models, but often failed to sell them to the services because the models did not exactly meet military specifications. Or planes were contracted for and built to military specifications, but then proved ill suited to their expected purpose, thus limiting sales.[76] Raymond presented RAND as a solution to this problem:

> The more industry knows about military planning and the more military planners know about what is technically feasible, the greater will be the proportion of airplanes and missiles that turn out to meet squarely a military need and the smaller will be the proportion of duds. It follows directly that the nation will get more protection per dollar spent. This is the essence of the thought back of RAND.[77]

75. See letter from D. Douglas to E. Bowles, 18 December 1946, Folder "WE=RAND Dec. 1946," Box 1, E.L. Bowles Papers, NASM.

76. See Vander Meulen, *The Politics of Aircraft,* note 25.

77. "Introduction to RAND: First Meeting of the RAND Advisory Council (RAND Document No. 94)," p. 2, 12 December 1946, Folder "WE=RAND Dec. 1946," Box 1, E.L. Bowles Papers, NASM.

In summer 1946 Raymond and Don Douglas had wrestled with fitting RAND into the company's framework of interests. A proposed Douglas Institute for Aeronautical Research, connecting RAND to a program of laboratory research had never been realized. Here, it seemed, was a practical definition of RAND which could fit Douglas's and the industry's needs.

As with the industry trade associations promoted by Herbert Hoover in the 1920s, Raymond now presented RAND as a device for collective, voluntary cooperation among producers and buyers to ameliorate and control the vagaries of their market. Once cooperative negotiation had established requirements, then "it becomes industry's task, through competitive design to produce the best articles to meet or exceed the requirements."[78] This model of industry organization was not alien to the RAND Advisory Council, nor was Don Douglas's assumption of a leadership role in such a venture a first. In 1940 as President Roosevelt called for increasing levels of aircraft production, Douglas took the lead in organizing an informal twice-a-month gathering of eight west coast aircraft manufacturers to discuss common problems--personnel, material, subcontracting, production planning, and the dilution of expertise as work expanded. In 1942 aircraft production continued to escalate and there were calls for federal intervention to manage this crucial area of manufacture. In response, the Douglas group established themselves as a nonprofit corporation, the Aircraft War Production Council, to plan aircraft production throughout the war, on a voluntary basis, independent of, yet working with the government. In 1943 the Council broadened its membership to include

78. Ibid.

manufacturers around the country and was renamed the National Aircraft War Production Council. A central feature of this arrangement, because companies routinely manufactured planes originating at other firms, was the sharing of proprietary engineering and manufacturing information among members.[79]

But RAND was more than an opportunity to correct past failings of the aircraft market or extend the arrangements of the war. Wartime had highlighted the special role of technology and innovation in national life. RAND represented a broadening of the industry's possible contribution as a leader in matters of research and development. Raymond noted:

> The RAND contract might have been assigned to an educational or scientific institution. It was assigned to an industrial organization because it was felt that the competence required resided largely in the type of personnel possessed or which could be obtained by such an organization. But it was expected that the collaboration of others in the scientific and industrial world would be fully marshalled, on a selective basis behind the project.[80]

The reasons for locating RAND in industry stemmed in part from the well-established economic and production relations between the service and the industry. The end goal was still the making of weapons. But with war the industry and the service had experienced a new order of national importance, making it possible to envision the industry, not universities, as the locus of an

79. Although written in a breezy, self-promotional style, useful details on the Council are contained in its self-sponsored publication: Frank J. Taylor and Lawton Wright, *Democracy's Air Arsenal* (New York: Duell Sloan and Pearce, 1947). Donald Douglas's assumption of leadership during the war and in the RAND project stemmed, in large measure, from the fact that Kindelburger and Northrop started their careers working for Douglas.

80. "Introduction to RAND: First Meeting of the RAND Advisory Council (RAND Document No. 94)," note 77, p. 2.

organized program of research tailored to its mutual interests with the service. RAND, Raymond suggested, could marshal resources and expertise to achieve this end. Industry, and particularly the military, could have access on their own terms, through an institution of their own making, to the scientific community. This process indeed was already underway. RAND had defined a broad program of research outlined by Bowles and Collbohm in March and expanded on by John Williams in July--ranging from the all-inclusive "military worth" to narrow technological questions on propulsion and guidance. Through this program they had attracted, in addition to their industrial staff, an impressive roster of about twenty university consultants--from Harvard, Yale, Princeton, Chicago, the University of Pennsylvania, the University of California, and the Massachusetts Institute of Technology (MIT).[81] This overlapping of military-industry and university interests was predicted in the exchange between Eaker and Bush in April. There Bush viewed it with alarm; but here it was considered a source of possibility and optimism.

But the Advisory Council council had to choose a course for itself. As LeMay had said to Symington and Bowles repeated to the Council, "The military felt that this joining of forces could best be worked out by the parties concerned and you will note that its contact with you were [sic] merely for the purpose of stressing the importance of the project and soliciting your full cooperation. The details of the association have been left to us to determine."[82] As a start, they

81. Ibid., p. 8.

82. Ibid.

agreed to placement of technical personnel from parent companies on the project and suggested to Bowles that when other companies were brought in their role would be at the "working level" not as participants in the Council. They also agreed on a series of subcontracts to the four principal companies to investigate parts of a long-distance bombing study already underway to consider the interrelation among current and prospective bombers, bomb types, and scenarios of attack.

Despite the opportunities for initiative outlined by Raymond, the Council seems to have viewed their possibilities cautiously. The substance of the RAND program seemed of less interest than assuring a place at the table as they considered this unusual opening to the Air Staff. As he formed the Advisory Council in early December Douglas sought to strengthen the connection to the service by asking Arnold to serve on the council. Arnold demurred, informing Bowles that "I do not think this would be a good idea; but I do like to talk about what is planned, ways and means of expediting matters, and so on."[83]

Bowles too was concerned about this issue. He had already begun organizing the meeting between the RAND Advisory Council and military leadership he proposed in November. All the parties had agreed to convene at the end of January 1947. In mid December Bowles sought to strengthen the military-industry link by drawing Georges Doriot into the circle of the RAND Advisory Council. During the war Doriot was Quartermaster Corps's Director of the Military Plans Division;

83. Letter from H. Arnold to E. Bowles, 3 December 1946, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H. H. Arnold Papers, Library of Congress.

now he had returned to Harvard's Graduate School of Business Administration as a professor. Doriot traveled to Los Angeles at the end of December to meet with the Advisory Council. After the meeting Raymond wrote to Bowles that the council was "very much sold on him and feel that he can be of great assistance, as I do."[84]

Doriot's first task would be to help the Advisory Council prepare for the January meeting. In part this involved defining the scope of the RAND enterprise. Just entering into the fray, Doriot looked to Bowles and Raymond for guidance. Bowles, flush with the recent progress of events, suggested to Doriot that "I believe the Douglas Project should ultimately be made big enough actually to be an influence on air power as a national security asset. This of course means that there is just as much responsibility for the Project to contribute to those aspects which have to do with a healthy peacetime air transport system as there is obligation to do those things for a healthy air arm per se."[85] Raymond asked Doriot to draft a statement of policy and procedure which would cover RAND's relations with elements of the Air Staff and War Department which had already had contact with the project, as well as relations with the Navy, JRDB, the Central Intelligence Group

84. Letter from A. Raymond to E. Bowles, 2 January 1947, Folder "War Effort--RAND Letters, 1944-48," Box 1, E.L. Bowles Papers NASM.

85. Letter from E. Bowles to G. Doriot, 16 December 1946, Folder "Chron File 1946," E.L. Bowles Papers, NASM. During fall and winter 1946 Bowles, in concert with Arnold, was increasingly active in the question of the relation of the commercial airlines and civil aviation to the military. See, for example, letter from E. Bowles to H. Arnold, 2 January 1947, Folder "Correspondence 1946-58 between Arnold and Bowles," Box 214A, H. H. Arnold Papers, Library of Congress.

(CIG), the State Department, and the Manhattan Engineer District.[86] Bowles and Raymond seemed to have a near limitless sense of what the project might undertake and how it might connect to established centers of decision making.

Through January Bowles prepared for the meeting, which he regarded as the capstone of his efforts to build RAND in the image he and Arnold had envisioned. Bowles sent to Don Douglas and Raymond copies of Eisenhower's "Scientific and Technological Resources as Military Assets" and his November memorandum to Symington on RAND's history and organizing concepts. Bowles wanted to be sure that he and the council were building on the same ideas. The council itself met again in mid-January. Secretary Patterson, Symington, Eisenhower, Spaatz, LeMay, Aurand, General Lewis Brereton (chair of the Military Liaison Committee of the Atomic Energy Commission), the Advisory Council, Doriot, Vannevar Bush, and several others planned to attend. Writing to Eisenhower, Bowles noted that RAND was "our first serious formal bid to join hands with our outside scientific and technological resources in the interest of military planning," as pronounced in Eisenhower's policy directive of the previous April. Through the luncheon meeting, Bowles continued, "we hope to demonstrate unequivocally to the outside management that the War Department as a whole is behind this project, and that it is considered significant by top leadership."[87]

86. Letter from A. Raymond to E. Bowles, 2 January 1947, note 84. Attached to this letter was an outline prepared by Raymond for Doriot suggesting tasks and institutional relationships to be cultivated.

87. Letter from E. Bowles to D. Eisenhower, 9 January 1947, Folder "Correspondence 1946-58 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Libary of Congress.

Organizing the military side of the meeting seemed to go smoothly, but Bowles's long-running, tangled relationship with Bush intruded into the proceedings--at least from Bowles's perspective. The bureaucratic communication was perfunctory. On 17 January, Bowles noted matter-of-factly to Arnold that the meeting could serve a good end: "by thus bringing Dr. Bush into the picture I believe he will be more likely to support the project. Likewise, he will see that it has the complete backing of topside War department officials."[88] On the same day Bowles wrote a long letter to Bush, discussing a paper entitled "National Organization for International Affairs" Bush had drafted and then asked Bowles to review. Bowles was lavish in his praise and deferential to Bush's wider experience evidenced in the paper.[89]

But apparently Bowles's worries about Bush were nearer the surface than these communications suggested. On 20 January Bowles began a personal diary, in which he set down his reflections for the next year and a half. Doriot, the diary reveals, had a closer relationship with Bush than Bowles and served as a go-between, especially regarding RAND now that Doriot was affiliated with the Advisory Council. Before the 31 January meeting Doriot had several discussions with Bush to sound out his views on RAND and Bowles. Through Doriot, Bowles

88. Letter from E. Bowles to H. Arnold, 17 January 1947, Folder "Correspondence 1946-58 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Libary of Congress.

89. Letter from E. Bowles to V. Bush, 17 January 1947, Folder "Chron File," E.L. Bowles Papers, NASM.

learned initially that "Van is sold on Project RAND and will support it." Bowles recorded "I have a great weight taken off my mind."[90] Bush apparently also floated suggestions that Bowles might be asked to take over either Berkner's or Bush's positions at the JRDB.[91] Bowles was flattered. But Bush soon started to convey misgivings on the project, similar to those he expressed to Eaker months before. Bush, according to Bowles, thought Congress might object to a contract of RAND's scope and the cost-plus-fixed-fee arrangement. Bowles reflected, "considering his [Bush's] logical mind this loose argument is very probably the cover for jealousy because the project did not arise from his activities."[92] Bush also stood in the way of Doriot's participation on the Advisory Council. Bush felt that because Doriot was on the Board of Consultants for the JRDB, he could only serve as a member with Bush's blessing. Moreover, the question of whether Berkner would leave his JRDB position to be director of RAND was still in Bush's hands and undecided. As the meeting approached, wherever Bowles turned Bush seemed to be positioned in his path.

On 27 January Bush and Bowles met for lunch. To Bowles, Bush appeared alternately threatening and solicitous. Bush asked if Bowles would be interested in

90. Office Diary, Edward Bowles, January 20, 1947-July 12, 1948, p. 2, Box 1, E.L. Bowles Papers, NASM.

91. Ibid., pp. 4-5.

92. Ibid. While Bush's criticism regarding cost-plus-fixed fee contracts may have been disingenuous, such contracts had been the object of congressional concern during the war. Critics charged this type of contract made possible excess corporate profits at taxpayer expense. On this point see Irving B. Holley, Jr., *Buying Aircraft: Materiel Procurement for the Army Air Forces* (Washington, D.C.: Office of the Chief of Military History, Department of Army, 1964).

taking the position of "Secretariat of Air in the ultimate armed forces structure"--what would become the Secretary of the Air Force when unification was inaugurated in September 1947. Bush thought he might well be asked to serve as the "top man in the new unification plan" and could bring Bowles along with him. But surrounding this complimentary offer were slights. Bush refused to give Doriot his blessing to join the Advisory Council, and his position on RAND hardened. Bowles interpreted Bush's stands as a cover for competitive strivings. Bowles opined:

> I believe he sees in RAND a competing and perhaps more potential [sic] plan for integrating scientific and technological effort. JRDB, his own brainchild, he would like to have the outstanding and controlling device to administer research....JRDB was to be a coordinating body...not an operating agency. RAND, on the other hand, is both a planning and operating agency. Since it is being backed by several large aircraft organizations I believe Bush looks upon it with the mixed emotions of fear and envy.[93]

Bowles's comments seem equally a gloss on his own feelings about Bush.

Bush, though, was not the only source of anxiety for Bowles as the meeting approached. On the night before the meeting Bowles, Doriot, Raymond, Collbohm, and the Advisory Council met over dinner. During a discussion of RAND's activities, Collbohm, as interim director of the project, described some of the work underway. The Advisory Council members, particularly Kindelberger, were uneasy about the apparent lack of focus in the work--especially subcontracts with Collins Radio in Iowa on a "lethal ray," a device for delivering intense bursts of microwaves, and with the Batelle Institute in Ohio to study aspects of nuclear

93. Ibid., p. 6.

propulsion. Bowles noted, "Collbohm got into hot water very quickly and was baited by Dutch Kindelberger....The thing that was important to me was in Kindelberger's attack, and I think it brought out clearly, that up to the present time there was no clear cut program for Project RAND." Northrup and Egtvedt were concerned about this state of affairs, too. Bowles concluded somewhat absently, "I take it that a plan is going to be developed."[94]

This was an unsettled way to enter a meeting Bowles regarded as essential. Symington was at best uncertain about the project, Bush was covertly obstructionist, and the Advisory Council lacked confidence in Collbohm, and, perhaps by implication, Donald Douglas. The meeting presentations seem to have gone well. The Air Staff provided briefings on intelligence estimates of the "situation," the present strategic concept and base system, and "composition and deployment of AAF present and future."[95] This gave the Advisory Council a first hand appreciation for the possibilities of the project as a conduit to the Air Staff. Douglas's Arthur Raymond then briefed the meeting on RAND's major undertakings: the bomber study (called the Interim Study), John Williams's work on military worth, and the satellite study which had inaugurated RAND's research. Bowles, however, could not have been at his best. He confided to his diary, "I supported myself on benzedrine for I had been worn down by sinus infection and also Bush. I was most apprehensive because it was clear Bush was by no means completely sympathetic

94. Ibid., p. 9.

95. Agenda AAF-RAND Briefing, 31 January 1947, Folder "War Effort--Luncheon with Gen. Spaatz," Box 2, E.L. Bowles Papers, NASM.

toward Project Rand."[96] Bowles apparently rambled in some of his remarks on RAND's philosophy, only to be rescued by Spaatz and Raymond.

Bowles was the only one who seemed to have recorded any detailed impressions of the meeting and its results. His reflections in the aftermath of the meeting were mostly filled with an escalating antipathy toward Bush. He felt Bush had been arrogant in parts of the meeting and "displayed the crudeness which somehow has always been associated with his makeup."[97] Immediately after the formal sessions Bush, Doriot, and Bowles met, with Bush suggesting that JRDB either directly or through the Air Staff could ask RAND to study selected problems. Bush's suggestion was a not-so-subtle move to remove the Advisory Council from the picture and supplant the JRDB in its place. Bowles let his pique show in his diary and in his communications with Arnold. He reported to Arnold that the meeting was a success, but "the only somewhat sour note was Bush's attitude. I watched him at the luncheon and he gave the appearance of a very much spoiled, small boy." And this personal attitude, Bowles relayed, would lead to a conflict on RAND and more generally on the understandings for organizing science and technology in postwar years:

> ... I suspect he is very much bothered, mainly because it did not spring from his own mind. After all, a person of his ambitions and militant pride will look with anxiety on any activity that shows signs of prospering independently. He sees in RAND a mechanism by which the armed forces themselves can gain powerful help without having to do obeisance to a controlled group of scientists outside the industry. Somehow, as I see

96. Office Diary, Edward Bowles, note 96, p. 10.

97. Ibid., p. 10.

> it, we are faced with a conflict between the Bush leadership and the industrial leadership.[98]

Arnold's response to Bowles was reinforcing:

> I am not surprised at the action of Van Bush. You remember I have preached the gospel of the AAF's standing on its own feet, scientifically, just as soon as it is able....There is no reason why the AAF cannot take care of itself, after a few years of special preparation. I never thought it possible to get the most out of a civilian committee to whom the AAF would have to go for help, as it did go for help when we needed it.[99]

Underlying the personal animosity, whether genuine or an amplification of Bowles's sensitivity, were these two conceptions of postwar organization. Arnold, Bowles, the aircraft industry, and some military officers on one side; the elite scientific community represented by Bush on the other. The meeting of military and industry leadership, which was an exclamation point to more then a year of effort for Bowles, did not clarify or join the contest of visions that Arnold and Bowles accurately described. Rather it was the beginning of the end for their strenuous effort to recast the service and its external relations with industry to their image. The meeting did not provide the acceleration of effort and cooperation Bowles had hoped. Instead it served the purpose of creating a temporary network of personal connections and interests, but the question of how RAND would build on this high-level blessing and serve as a mechanism to link the industry and the Air Staff in cooperative planning remained unanswered.

98. Letter from E. Bowles to H. Arnold, 19 February 1947, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

99. Letter from H. Arnold to E. Bowles, 3 March 1947, Folder "Correspondence 1946-48 between Arnold and Bowles," Box 214A, H.H. Arnold Papers, Library of Congress.

Bowles expected the Advisory Council to be impressed by the military imprimatur and take the initiative. But this seems not to have been the case. The meeting led to no surge of activity on the part of the Advisory Council or in the technical exchanges among RAND, Northrup, North American, and Boeing.[100] A large part of the problem was that the level of RAND research effort during its first year did not measure up to Bowles's grand organizational ambitions. A staff of around one hundred still groping toward a research agenda in the unsettled planning landscape of 1946 and 1947 was not a sufficient core of activity around which to restructure internal relations within the Army Air Forces, build a new relationship between the industry and the Air Staff, and establish a role as a "player" with the Navy, JRDB, CIG, and the State Department.[101]

100. Lawrence Henderson was head of the RAND Washington, D.C., office and a participant in some of the Advisory Council sessions. He knew Bowles well, too, having served as a member of Bowles's consultant corps during the war. Henderson recalled Bowles's frustrations with Donald Douglas and with the Advisory Council's passive support of RAND: "he [Bowles] was wrong on both counts, because the last thing you wanted was a lot of personal attention from the president of an aircraft company, for God's sake. I mean Donald Douglas was a very fine man and a very able person, but the last thing that RAND needed was some supervision from an executive of an aircraft company. When we had this crazy council that we had, with Clair Egvedt and Dutch Kindleberger and Jack Northrop and Donald Douglas, they never did anything except sit there and look like wise old owls while we told them what we were doing. Fortunately they never told us what to do and what not to do, which was very good. I think actually that that's largely due to the fact that all of them respected Arthur Raymond, and Donald Douglas said to himself, "Well, look, why should I get involved in this damned thing? Let Ray handle it." Lawrence Henderson, Oral History Interview, 1989, RAND History Project, NASM.

101. On RAND staffing levels in this period and later see, for example, the report of operations in "Eleventh Semi-Annual Meeting of the Board of Trustees, Agenda Material," November 1959, RAND Archives.

The initiative for defining RAND, whether Bowles liked it or not, was located in those most active in RAND's day-to-day work--the RAND staff led by Collbohm and those in the Air Staff and the AMC with whom they worked most closely. The attention of the RAND staff was focused on building a research program tailored to the interests of their service principals.[102] And RAND was gaining a measure of trust in this arena--despite a lack of coherence in their early research program. In February 1947 the Air Staff charged RAND with investigating requirements for defense of the United States against air attack--a research, development, economic, and political problem of the first order. This and the studies of the bomber, missile, and satellite questions already underway would dominate the RAND research agenda for the next several years.

This pragmatic shift from Bowles's attempts to secure new managerial and decision-making structures to what the RAND staff could actually accomplish was reinforced by weaknesses already described in Bowles's scheme. Bowles himself was an advocate with diminishing power. He cut back his constancy to three days per week in spring 1946, and then when Kenneth Royall replaced Patterson as Secretary of War in summer 1947, Royall asked Bowles to depart. The ostensible reason was that Bowles position as consultant to the Secretary of War was no longer needed as the National Military Establishment, the new organizational creation of unification, came into existence in September 1947. In mid August Bowles was gone from the job that had been the pinnacle of his career. Bowles returned to

102. The RAND professional staff and their work are described in the following chapters.

MIT, his home before the war and the site of his greatest professional frustrations. Ironically, Bush made this possible. Concerned for Bowles's welfare, Bush acted as an intermediary between Bowles and MIT president Karl Compton. Bush had recommended Bowles for the advisory post to Secretary of War Stimson in 1942 as Bowles's relationship with MIT and Compton disintegrated. Once again, despite Bowles's peculiar love-hate attitude toward him, Bush helped Bowles through another difficult professional transition, intervening with Compton to secure him a consulting professor's position at MIT.[103] With these changes, Bowles's leverage and importance in the Air Force evaporated, ending what he considered to be the high point of his career. He continued to serve as an occasional adviser to the military into the 1950s from his post at MIT, but devoted most of his time to consulting with industry.

The RAND Advisory Council had been constituted in mistrust, and Don Douglas's enthusiasm was irregular. The Council met occasionally through 1947 and into 1948. In September 1947, Raymond wrote to Bowles talking in hopeful terms about bringing other companies in at the "working level" and adding a scientist or non-aircraft industrialist to inject fresh perspective.[104] There was no indication the Council engaged in shaping RAND's research program or organization, nor did they view themselves in the associationalist mold Bowles pushed for. The Council saw themselves neither as an instrument for industry cooperation nor

103. On Bush's assistance to Bowles in securing a postwar position at MIT see Folder "E. Bowles," Box 107, V. Bush Papers, Library of Congress.

104. Letter from A. Raymond to E. Bowles, 10 September 1947, Folder "War Effort--RAND Letters, 1944-48," Box 1, E.L. Bowles Papers, NASM.

as a managerial adjunct of the service. In contrast with the cooperative arrangements so readily established during the war, there simply was not enough at stake to encourage the Council in these directions. During the war, industry was stimulated to adopt cooperative arrangements by the sheer scale of the production effort and government threats in 1942 to appoint a "czar" to manage aircraft production.[105]

Raymond argued to the Advisory Council in December 1946 that cooperative effort was required to manage efficiently the drastically lower level of production of the immediate postwar years. But in the areas in which RAND was building expertise--missiles, satellites, and intercontinental bombing--no production contracts were in the offing.[106] While diminished postwar budgets stimulated the industry to consider the kind of cooperative management advocated by Bowles and seconded by Raymond, such a move was insufficient to address the industry's dramatic transition from wartime plenty to postwar penuriousness. Industry leaders, including those serving on the RAND Advisory Council, saw the solution to their problems in more traditional terms: forming alliances with members of the military and Congress to gain larger appropriations for aircraft procurement. By the middle of 1947 such efforts were picking up steam as both President Truman and Congress organized special commissions to study and make recommendations

105. On this point see Holley, *Buying Aircraft*, note 92.

106. For example, the basic contracts for the next generation of medium and long-distance bombers (the B-47 and B-52) had already been let by war's end.

on policy and funding for military and civilian air needs.[107] Advisory Council members, individually and through their trade association, the Aircraft Industries Association, actively lobbied for increased appropriations. At least for the council, efficient, cooperative management seemed less of a solution to their problems than an adequate flow of contract money.

Without the muscle to solve the basic problems of the industry, the value of the Advisory Council as a means to connect RAND to Douglas (which Raymond had struggled with through 1946) and to the industry seemed hollow. The council's hesitant style was not helped by the inability of Bowles to arrange an informal military voice, such as Georges Doriot, to maintain a steady liaison with the Air Staff. All of these shortcomings were compounded by Raymond's and Bowles's inability to recruit a strong, nationally recognized figure to lead RAND. Through 1946 and 1947, first Berkner, then Louis Ridenour and Lawrence Hafstad turned them down.[108] Despite Bowles's hopes for RAND's importance, the industry setting and the two-year length of the contract apparently discouraged top candidates.[109]

107. These developments will be discussed in more detail at the beginning of Chapter 5. An overview of the battles on aircraft procurement and their relation to national security policy and budgets is Melvyn Leffler, *A Preponderance of Power: National Security, the Truman Administration, and the Cold War* (Stanford,CA: Stanford University Press, 1992. A more detailed, but tendentious account is Frank Kofsky, *Harry S. Truman and the War Scare of 1948* (New York: St. Martin's Press, 1993).

108. On this see letter from E. Bowles to James Conant, 21 May 1947, Folder "Chron File," E.L. Bowles Papers, NASM.

109. Arnold, Bowles, and Douglas had a tacit understanding to fund the project for three years. But contract law only allowed two-year agreements. RAND had to have a congressionally-approved extension for its third year and any subsequent years.

The lack of initiative on the part of the Council was fatal to Bowles's conception of RAND. His strategy to solve the challenge of postwar weapons research, development, and production was modeled on the notion of an extended corporation. Through a contract and mutual cooperation the Army Air Forces and the industry could perform their specialized functions, acting for a common purpose, for the common good. Military and industry leaders would act as a loose board of directors to plan and coordinate their respective roles. Bowles imagined a solution to the challenge of weapons rooted in new institutional structures, a leadership class, and a well-circumscribed process of decision making. Given such a setting, leaders could direct the social resources necessary to accomplish the common good. Both Bowles and Bush shared this administrative approach to the challenge of weapons production--their difference was in who would make decisions and through what institutional structures.

The Advisory Council only briefly joined in Bowles's administrative vision, and military leaders such as Spaatz, Eaker, and LeMay never felt completely free to play the roles Bowles and Arnold hoped for. With Arnold gone, there was no consensus among Air Staff on how to manage research and development relations with industry. While LeMay supported Bowles, he was also attentive to the perspectives of Symington and the AMC. LeMay never took the initiative to push the Advisory Council into a more active role or forge stronger links to the industry through them. As Raymond did with the Advisory Council, LeMay too confronted the realities of retrenchment and diminished budgets. Elaborate and broad cooperative arrangements in such circumstances did not seem worth the effort. With unification in 1947, LeMay's post of Deputy Chief of Staff for Research and Development was abolished. He was reassigned as Commander of the United States Air Forces in Europe, and responsibility for the RAND contract was given to the Air Staff element presiding over materiel--the very parts of the service Bowles sought to limit with the LeMay post and with RAND. Unification completely undid all of Bowles's efforts to elevate research and development in the service chain of decision making.

Conclusion

Despite these failures and Bowles's sometimes overly sensitive style, his exertions illustrate critical facets of the attempt to translate the ideology of preparedness into concrete institutional and political arrangements in the first years after the war. A close examination of Bowles's and Arnold's actions offers a contrasting view to existing accounts of RAND's early history. RAND's placement at Douglas was not a matter of mere convenience, nor was its research program a simple extension of wartime operations research. Moreover, while the project was part of the broad push to retain relations between science and the military after the war, it was organized around ideas diametrically opposite from the better known ventures of Vannevar Bush. RAND's transformation into a nonprofit corporation in 1948 was inseparable from the strivings and eventual failure of Arnold's and Bowles's effort to advance an associationalist mode of cooperation between the service and industry.[110]

As the principal driver in shaping RAND and its connections to the Army Air Forces, Bowles sought to create a specific institutional device, centered on the interests of the industry and the Air Staff, for solving the challenge of preparedness. RAND was conceived in the context of this challenge. Yet RAND differed fundamentally in motivation from the strategies of Bush to reconcile science and the military as embodied in his proposed National Research Foundation, the JRDB, and the RDB. Bush's call for a position for the scientific community equal with the military in prestige, authority, and funds was never realized. Bowles's Air Staff-industry model, collapsing the boundaries between the civilian and the military, proved even more elusive. Bowles's patchwork structure of institutional innovations, contracts, policy papers, personal persuasion, and shared communities of interest was inadequate to his reach. But his call for a military-industry inspired associationalism and its near achievement suggests the seriousness of the exploration for new institutional arrangements and of the enhanced leverage of military leaders in national life. All the points of failure noted above were instrumental in the demise of Bowles's associationalist experiment.

But American political culture was as well. As represented by Symington and the hesitations of LeMay, the project encountered limits to acceptable institu-

110. The most extensive accounts of RAND's early history are in Bruce Smith, *The RAND Corporation: Case Study of a Nonprofit Advisory Corporation* (Cambridge, MA: Harvard University Press, 1966); Fred Kaplan, *Wizards of Armaggedon* (New York: Simon & Schuster, 1983); and David R. Jardini, "Out of the Wild Blue Yonder: The RAND Corporation's Diversification into Social Welfare Research, 1946-1968" (Ph.D. diss, Carnegie Mellon University, 1996).

tional strategies for coordinating and planning the managerial interests of industry and the Air Staff. It was the collapse of Bowles's associationalist vision that led to RAND's move from Douglas to independent status as a nonprofit corporation. The reasons for locating the project in industry were gone.

If the service was to control scientific and technological resources for its own interests as advocated by Arnold, Eaker, LeMay, and Bowles, it would have to devise other strategies. Funds, contracts, and interest group politics were ready, powerful, acceptable tools for achieving these ends and actively used. But their exercise tended to be diffuse and distributed in the military bureaucracy. The ideology of preparedness implied not just simple access to and influence over civilian resources, but also deliberate, organized leadership to manage and guide the use of these resources. Such leadership required some institutional expression to be effective. Arnold and Bowles both believed this. The demise of the associationalist model of RAND left this perceived need unfulfilled. The RAND staff headed by Collbohm and their military counterparts still accepted this tenet of preparedness, regarding it as a problem to solve. Their strategy was not to seek an administrative solution, but to build on the work of John Williams. The key was to define, as Williams had started to do, a research domain embracing technology, war, and society. Research, so defined, would provide a means to relate the civilian and the military, the technological and the political, and to navigate the strictures of American political culture that so bedeviled Bowles.

Chapter IV

Reshaping RAND:
Air Warfare as a Domain of Research

In mid January 1947 Edward Bowles wrote to Warren Weaver, a wartime colleague who had served as Chief, Applied Mathematics Panel (APM), National Defense Research Committee. Bowles was feeling expansive in anticipation of his long-planned conference with Eisenhower, Spaatz, Bush, and others to cement an associationalist cooperative arrangement between the aircraft industry and the Army Air Forces. Bowles praised Weaver for a paper written a year earlier, "Comments on a General Theory of Air Warfare," which explored the possibility of constructing a comprehensive mathematical model for modern air warfare.

The paper represented a distillation of Weaver's wartime experience applying operations research techniques to military problems. These techniques made a critical contribution to the war effort through the work of the APM and other operations research groups in the U.S. Navy, Army Air Forces, and in Britain, where this analytic approach to military problems was first developed.[1] Operations

1. On operations research in Britain see Air Ministry, *The Origins and Development of Operational Research in the Royal Air Force* (London: Her Majesty's Stationary Office, 1963); Joseph M. McCloskey, "British Operational Research in World War II," *Journal of the Operational Research Society* 35 (1987):453-470; and Maurice Kirby and Rebecca Capey, "The Air Defense of Great Britain, 1920-1940: An Operational Research Perspective," *Journal of the Operational Research*

research had proved its utility in military activities that could be modelled in terms of well-defined variables. One of the specialties of the AMP was analysis of the most efficient application of guns and fire control devices in fighter-to-fighter combat. Weaver sought to extend the application of such mathematical techniques to broader and more complex analyses. In his "General Theory" he outlined a research domain that moved beyond the challenges of modelling the battlefield to encompass social and technical aspects of air warfare, including "Army-Navy-Air Force organization and policy" and "public support of effective measures for military preparedness."[2] The purpose of the "general theory" was to enhance military understanding of this complex domain and, thus, improve decision making.[3]

Bowles had a keen interest in operations research and the application of mathematics to managerial decision making. Such tools, Bowles thought, could provide a rational basis for the cooperative managerial structures necessary to prepare for modern war. Bowles received Weaver's effort with high interest, and,

Society 45 (1996): 26-52. On the American experience see M. Fortun and S.S. Schweber, "Scientists and the Legacy of World War II: The Case of Operations Research, *Social Studies of Science* 23 (1993):595-642.

2. Warren Weaver, "Comments on a General Theory of Air Warfare," January 1946, Folder "Air Warfare--Warren Weaver," Box U, E.L. Bowles Papers, NASM.

3. A significant fraction of the panel's work was related to air warfare problems such as optimal tactics for fighter engagements and efficient use of fire control systems. On these points and the panel's work in general see Larry Owens, "Mathematicians at War: Warren Weaver and the Applied Mathematics Panel, 1942-1945," in David Rowe and John McCleary, eds., *The History of Modern Mathematics, Volume II: Ideas and Institutions*. (New York: Academic Press, 1989):287-305.

with his penchant for rhetorical excess, extolled the work: "It is a beguiling development of what to me is a tantalizing subject, and you have done the job with your usual tincture of acidulous humour. Your barbs and facetious darts made me tingle with satisfaction."[4] But Bowles's praise would prove ironic. His own initiative to provide an administrative solution for drawing together the military, industry, and academia in preparation for modern war would falter over the coming months. Weaver's ideas, as represented in his paper and elaborated at RAND in the years 1946-1950, would provide the basis for an alternative strategy for integrating the military and the civilian. Researchers at RAND, led by John Williams, a wartime colleague of Weavers's, developed the idea that the study of air warfare might constitute a new field of science. Such a science, grounded in a general theory as Weaver proposed, might recast the problems of administration and politics that had confronted Bowles. Research and the knowledge it generated, legitimated by the methods of science, might be used to coordinate the disparate interests of private and public institutions involved in the military enterprise.

This chapter focuses on RAND's role in crafting such a strategy through the work of John Williams, Warren Weaver, and others. This chapter will also examine how their work shaped RAND's sense of purpose, its research practices, the composition of its professional staff, its organization, and how the effort to make a science of air warfare resulted in the creation of RAND's most significant product, systems analysis. The story shifts from the interests and activities of

4. Letter from E. Bowles to W. Weaver, 16 January 1947, Folder "Chron File 2 May 1945-13 Aug 1947," [no box number], E.L. Bowles Papers, NASM.

Arnold, Bowles, and LeMay on the Air Staff to work at RAND. The exposition in this chapter overlaps chronologically with the work of Bowles described previously. The effort to articulate a science of air warfare developed in concert with Bowles's push for an administrative solution to the problems of weapons development and modern war. The failure of the latter provided an opening for this alternate means to coordinate postwar institutions and interests. In this chapter and the next the mode of explanation shifts, too. In previous chapters a few individuals and their interests dominate developments. As the focus shifts to RAND and the development of a science of air warfare, individual contributions are still significant but less decisive, bounded by their institutions and circumstances.

RAND's Political and Institutional Context, Fall 1947

After Bowles's and LeMay's departures in late summer and fall 1947, no one on the Air Staff had the same passionate interest in RAND's definition and development. RAND would now have to create its own identity and promote it to the Air Force. In this period, RAND's effort would take shape through the same problems that had motivated Bowles's work. Leaders at RAND and within the Air Staff believed that the constituent elements of society--the military, industry, universities, the average citizen--needed to be organized and prepared for future war. The failure of Bowles's work reflected, in part, the difficulty of implementing an approach which relied on central managerial controls (whether direct or through associationalist structures) supervised by the Army Air Forces. American political culture militated against such arrangements. So did the institutional pluralism that was part and parcel of that political culture. As Bowles's efforts showed, it was difficult to draw together disparate elements within the service, let alone civilian institutions such as aircraft companies.

Equally, if not more important, was the institutional turmoil surrounding demobilization, preparations for unification, and then implementing the changes brought on by the transition to the National Military Establishment in September 1947. Air Force leaders were consumed with creating an independent service and readying themselves to fulfill the centerpiece of American strategy for fighting the next war: delivering atomic bombs with long-range bombers. Despite political consensus, including President Truman and the Congress, on the crucial role of the Air Force in postwar military strategy, there was strong disagreement on the proper level of funding as Truman sought to strengthen the civilian economy. In the period up to the start of the Korean War in June 1950, the ambitions of service leadership and of air power advocates in Congress and industry conflicted with Truman's efforts at restraining military spending and balancing the federal budget. Over several years Truman's budget-cutting efforts pushed the service to scale back the size of its force from 133 groups to 48 groups on the eve of the Korean War.[5] This resistance in the political arena to arguments for a larger air force did not stem the lobbying efforts of Air Force Secretary Stuart Symington, the industry, and supporters in Congress for larger budgets and more planes. But Truman's position did force service leadership during this period to assess continually how to

5. On the group concept in service planning see Herman Wolk, *Planning and Organizing the Postwar Air Force, 1943-1947* (Washington, D.C.: Office of Air Force History, 1984). "The group, made up of three or more squadrons and support elements, was the basic AAF [Army Air Forces] combat unit. The group would consist of 35-105 planes and from one to two thousand men" (p. 31).

ready airplanes, crews, and bombs for its nationally vital mission. Air Force leadership perceived they had to do more with less and looked for strategies to improve management and coordination among service commands and offices as well as in their relations with industry.[6]

This push for economy within an Air Force, large and complex after the wartime buildup, only highlighted the difficulties of coordination that had so occupied Bowles and Arnold. Behind Bowles's approach to coordination were two complementary concepts: managerial inventions to link industry and the service, followed by use of such arrangements to plan the allocation of resources. Despite Bowles's departure from the scene in August 1947 these issues were still germane. Unification through a new National Military Establishment in September 1947, bringing all three services into one administrative structure, was a partial response to this challenge. So was the Vannevar Bush-inspired Research Development Board (RDB), created as part of the unification legislation to ameliorate rampant interservice competition and duplication in weapons development. Bush's objective was primarily internal to the new National Military Establishment (NME): to

6. There are several useful sources on the period before the Korean War and the political struggles over military funding, Truman's domestic priorities, the maneuvering of air power advocates, and the sharpening international conflict with the Soviet Union. See Steven L. Rearden, *History of the Office of the Secretary of Defense: The Formative Years, 1947-1950, Vol I.* (Washington, D.C.: Office of the Secretary of Defense, 1984); Melvyn P. Leffler, *A Preponderance of Power: National Security, the Truman Administration, and the Cold War* (Stanford, CA: Stanford University Press, 1992); and Samuel Huntington, *The Common Defense: Strategic Programs in National Politics* (New York: Columbia University Press, 1961). A well-researched but tendentious account of these issues is Frank Kofsky, *Harry S. Truman and the War Scare of 1948* (New York: St. Martin's Press, 1993).

critically appraise the military's management of its burgeoning research and development projects. But Bush also thought that a crucial benefit of this effort would be to regulate the flow of military funds into universities and industry. In the Navy and Air Force postwar operations research groups also addressed such management questions by analyzing the interconnections among technology, organization, tactics, and strategy. But, as with the management efforts, the scope of such activities tended to be circumscribed.[7]

In short, both managerial and knowledge approaches were pursued but with limited objectives--at least compared to the efforts and conceptual perspectives of Bowles and Weaver. The insight of Bowles and of Bush in his work for the RDB was that powerful de facto political and institutional ties were being constructed through the expenditure of funds from military commands and program offices to academia and industry. What was required, they thought, was the active involvement of military leadership (for Bowles, the Air Staff and the Commanding General of the Air Force; for Bush, the Joint Chiefs of Staff in concert with scientists) to control the direction of these relations already in the making and, thereby, ensure that these activities served the military mission and national interest. For Bowles, as a protege of General Arnold, the larger issue was implementing through new social inventions, such as RAND, a national program of preparedness; for Bush it was protecting the autonomy of university science. The larger and tougher question of how to coordinate actively the work of the military, industry, and

7. On the Navy's postwar work in operations analysis see Keith R. Tidman, *The Operations Evaluation Group: A History of Naval Operations Analysis* (Annapolis: Naval Institute Press, 1984).

universities and to prepare for the demands of future war had not been directly addressed by any of the organizational changes of 1946 and 1947. In this context, the prospect of defining air warfare as a comprehensive social and technical domain, as a subject to be studied and analyzed scientifically, came to be seen by leaders in RAND and the Air Force as a means to achieve some coordination and managerial direction over the sprawling military enterprise. It was this step, in the eyes of Frank Collbohm and other RAND principals, that set the RAND experiment apart from other postwar inventions.

Warren Weaver and John Williams: A General Theory of Air Warfare

Underlying Weaver's paper were two intertwined developments of the war. One was represented by Bowles: The unprecedented integration of scientists and engineers into research and development of new weapons and into military life. The other was the development of operations research as a body of analytic practices focused on the interaction of weapons, battlefield operations, and military organization. The definition of the field was imprecise. It often meant the application of mathematics to battlefield operations that could be reduced to dynamic physical terms or described through probability or statistical approaches. Economic concepts of utility also found a home in the emerging field as a means of analyzing bombing campaigns and the selection of targets. Operations research, while most often identified with mathematical modelling, embraced any disciplinary approach that provided analytic insight into battlefield problems. Operations research groups, using scientists, engineers, economists, statisticians, lawyers, and other experts, became commonplace during the war.[8] But the enthusiasm of Weaver, Philip Morse of the Massachusetts Institute of Technology, and others for operations research at war's end fit nicely into the period's prevailing ideology of preparedness and belief in technological innovation as a permanent fact of the postwar world.[9] New technologies, often more complex, required special analytic effort to define their relations with tactics, strategy, and military organization and culture. The proper mutual adaptation of technologies and military practices would be ongoing because of innovation and would be crucial to ensure preparedness. Weaver's paper was, thus, representative of the hopes and aspirations of an emerging community of operations researchers.

By the time of Bowles's letter in January 1947 Weaver had returned to his prewar position at the Rockefeller Foundation as manager of their program of philanthropy to the natural sciences. But Weaver still retained an interest in the subject of his paper. Indeed, with its exploration of the application of mathematics to the varied social and technical domain of the military, Weaver's paper had become an intellectual touchstone for John Williams's very similar endeavors at RAND beginning in summer 1946. This connection was not coincidental. Williams had worked for Weaver at the APM and drew on his wartime network of

8. On these points see note 1.

9. Morse was instrumental in establishing operations research in the Navy in World War II and actively promoted the field as an academic specialty afterward. He also served as the first deputy director of the Weapons Systems Evaluation Group, established in 1948, to conduct analyses for the Joint Chiefs of Staff, and also in 1948 joined RAND as a member of its Board of Trustees. The best account of Morse's activities is his *In at the Beginnings: A Physicist's Life* (Boston: MIT Press, 1977.)

associations to build up a small group of colleagues to elaborate Weaver's ideas in the RAND context. Weaver signed on in summer 1946 as a part-time consultant to RAND to participate in the effort.

Weaver's paper, as the title suggests, was mostly an attempt to define general functions and to enumerate variables that would constitute a mathematical description of air warfare, focusing largely on the most easily quantified aspects of the domain--hypothetical battlefield operations. Questions of organization, policy, and politics were mentioned in passing as requiring treatment in a general theory of air warfare but were left as problems for future study. The novelty of the paper was its ambition: the possibility that the salient variables of air warfare might be modelled completely by a series of mathematical functions. Mathematically described, air warfare could be quantified and, thus, the numerous variables of technology, social context, and the battle itself (given specific initial conditions and criteria for success) could be compared and assessed. The general theory, thus, was a method to identify for a given war situation a set of choices which resulted in "the largest margin of profit--the largest excess of return over cost" for the United States in conflict with an enemy.[10] The theory when more fully developed was intended as a tool for military decision makers, allowing them to distill down a range of social and technical variables to a simple numerical value indicating the outcome of a war--for good or ill. One might model present organization, strategy, and technology or some future state of affairs and examine how, with changes in variables, war outcomes might result in more or less profit. Coining a

10. Weaver, "General Comments ...," note 2, p. 11.

phrase that John Williams would soon adopt as a member of the RAND staff, Weaver called this measure of possible costs and benefits "military worth."

Recognizing the difficulties of defining and quantifying the myriad variables associated with air war, yet optimistic about the possibilities of mathematical modelling, Weaver illustrated his discussion with a thought experiment. Imagine you are at a computer, "a great Tactical-Strategic Computer," and you "begin to twiddle the decision variable dials." The most interesting case, Weaver offered, is when we watch:

> ...the behavior of the M.W. [military worth] dial when one alters the values set into the decision variable dials. *For then one is changing the military plan for the operation in question, and is observing directly whether the change is for the better or for the worse.* [emphasis in original] To seek the optimum plan, one would set into operation a mechanism which...shifts all the decision dials through cycles of accessible values, the resulting values of M.W. being recorded so that the maximum can be located and the corresponding set of optimum values of the decision variables D(n) determined.[11]

Weaver noted that "so complete and so formally mechanized an analytic procedure doubtless lies far in the future."[12]

But the major impediment to realizing this mastery over the planning and conduct of air war, in Weaver's view, was not the limitations of mathematics, computing, or the massive data collection required by his enterprise. It was convincing political and military leaders to make a science of the complex phenomena before them. It was grounding the decisions associated with war not in individual

11. Ibid., pp. 13-15.

12. Ibid., p. 15.

"judgment and experience and common sense" but in organized analysis. Decisions based on individual experience may be well intentioned but were often unwittingly "disorganized and feeble intuitive shadows of a real analysis."[13] Such intuitive decision making, Weaver argued, echoing the arguments of Arnold on preparedness, was ill adapted to the new era of modern war. The possibility of a surprise, devastating attack on the United States--a worry of preparedness advocates--required planning and choice based on the clearest, most rigorous thought.

Weaver's theories called for a change in military culture. Unlike Edward Bowles, though, Weaver's own inclination was not to dedicate his professional energy to this task. But through his paper, through John Williams, and through his part-time consulting position at RAND, Weaver's perspective was elaborated. It was not coincidental that Weaver's ambitious proposal to describe mathematically air war found a home at RAND. The network of personal associations forged through the AMP and which were replicated in part at RAND was one crucial factor. But another was the organizing ideology with which Arnold and Bowles constituted Project RAND--as an institution embodying the merging of military, industrial, and academic cultures that modern war seemed to require. All of a nation's resources, institutional and intellectual, needed to be actively coordinated and managed to ensure national survival. Weaver advanced the same conception of modern war in his paper. The difference was that the focus shifted from an administrative to an intellectual solution: instead of drawing together institutions, Weaver

13. Ibid., p. 19.

sought to draw together and reorient traditional disciplines, focusing their collective expertise on a new research domain.[14]

But it took a specific set of circumstances for Weaver's prescription to move from the musings of his paper to a managerial tool. Filtered through John Williams and the particular context of RAND's research activity and relations with the Air Force in the period 1946-1950, Weaver's ideas would help shape two interconnected hallmarks of the RAND enterprise. One was the establishment of social science, political science, and economics at RAND as areas of expertise to inform better the broad studies of air war envisioned by Weaver, Bowles, and others. The other was to articulate a method of analysis for studying this new domain, which would interrelate mathematics, the natural science and engineering, and the "softer" sciences. Building on Weaver's notions of military worth, Williams would help to develop RAND's signature product, systems analysis.

John Williams, Military Worth, and Defining RAND

In September 1947, on the eve of unification, Edward Bowles had departed the War Department, and Curtis LeMay was preparing to leave his position as

14. Weaver followed a similar approach before the war in his work at Rockefeller where he was instrumental in defining the subject of molecular biology. He used his leverage as dispenser of the foundation's grants to break down established academic disciplinary boundaries among biology, chemistry, and physics to establish a new field. In his "General Theory" paper he sought to bring together mathematics and economic utility theory (relying heavily on John von Neumann's and Oskar Morgenstern's *Theory of Games and Economic Behavior*) as a first step in defining a new research domain of air war. On Weaver's important role in the history of prewar science and foundation patronage see Robert S. Kohler, *Partners in Science: Foundations and Natural Scientists, 1900-1945* (Chicago: University of Chicago Press, 1991), chapters 9-13.

Deputy Chief of Staff, Research and Development, as part of a planned Air Staff reorganization. The reorganization, which took effect in October, shunted RAND's point of contact in the Air Staff from near the top to a subunit of the Deputy Chief of Staff for Materiel office.[15] The shift was a final exclamation point to the unraveling of Bowles's efforts to establish RAND as a novel administrative construction for linking industry, academia, and the leadership of the service. RAND was now a part of the very element of the Air Force Bowles sought to reform and manage through his institutional invention.

RAND was still a developing organization when it confronted this period of change within the Air Force and the new National Military Establishment. Professional and support staff numbered around one hundred.[16] In May, the project had placed some distance between itself and its parent company by moving from the Douglas plant in Santa Monica to offices in the city's downtown area. Led by Frank Collbohm and a small administrative staff, the organization in early fall 1947 was divided into five research divisions: Evaluation of Military Worth, led

15. With this reorganization, the hierarchy of the Air Staff went from the Chief and Vice Chief of Staff to three Deputy Chiefs of Staff--Operations, Materiel, and Personnel and Administration. Although these new posts carried that same "deputy" designation as LeMay's office, they carried less authority and institutional leverage. Each of the new deputy posts then administered a series of directorates and offices. RAND reported to the Director, Research and Development, under the Deputy Chief of Staff, Materiel. A full description of the reorganization can be found in *Report of the Chief of Staff, United States Air Force, to the Secretary of the Air Force* (Washington, D.C,: USAF, 1948).

16. The project's early organization is detailed in Commander Brown, "Commander Brown's First Report--Origin and Objective of Project RAND," 8 August 1947, RAND Publication RAD-138. Commander Brown's reports, filed over the next two years, were part of an effort by the Air Force and Navy to share information on RAND's activities.

by John Williams; Airborne Vehicles, led by L.E. Root, formerly a Douglas engineer; Rocket Vehicles, led by James Lipp, also a former Douglas engineer; Communications, led by D.K. Bailey; and Nuclear Physics, headed by David Griggs, a geophysicist who had been a member of Bowles's consultant corps during the war. The great majority of the professional staff was concentrated in the Airborne, Rocket, and Communications sections and were engineers, many of them drawn from Douglas. The emphasis on engineering expertise reflected the focus of RAND's first studies: an ongoing technical assessment of the possibility of developing an earth orbiting satellite and a companion launch vehicle, and a grouping of smaller studies on the state of the art for bombers, fighters, and aircraft engines.

Of the original $10 million dollars allocated for RAND, the project had spent just over a million dollars, divided almost equally between in-house activities and subcontracts. The subcontracts were largely in technical support of these first studies--Battelle Memorial Institute researched "materials, fuels, and the problems of their application to supersonic vehicles"; Boeing investigated the relative merits of reciprocating, turbo prop, and turbojet engines in long-range bombers; North American Aviation examined the role of fighters in offensive and defensive operations as well as missile propulsion; Northrup studied the possibilities of the "flying wing" as a bomber platform; Westinghouse helped assess the state of the art in communications and radar; and Collins Radio explored the possibilities of high-intensity microwaves for use as a weapon and as an air defense tool (often referred to as the "death ray" in RAND's early publications).

The use of subcontracts was part of a strategy to build a network of cooperative institutional relationships, as well as a way to diminish concerns over competing with industry and academia for skilled personnel in short supply. Toward the same end, RAND (particularly John Williams and David Griggs) actively recruited consultants from academia. These also would include several of Williams's colleagues from the AMP, including Warren Weaver. Notables from the scientific community included Harvard's George Kistiakowsky, Berkeley's E.M. McMillan and Luis Alvarez, the University of Pennsylvania's Louis Ridenour, and Yale's Lyman Spitzer.

Inter-institutional cooperation had been at the center of Bowles's vision for RAND. But as RAND developed in its first two years, this cooperation was manifested less through the shared managerial ideal Bowles had hoped for and more through the construction of a research domain centered on air warfare. The studies, the subcontracts, and the consultancies all served to build a community of engineers, scientists, and other academics engaged in defining and cultivating this domain. In piecemeal fashion, problems were articulated and a body of results and data created and interrelated. RAND was defining a role for itself as the institutional center for this activity. The first studies were opportunities to clarify assumptions about military operations, strategy, and institutional culture as well as to gather data on practices and weapons capabilities. RAND staff deepened their grasp of Air Force interests, organizational politics, and decision making through working contacts developed in preparing studies, in quarterly briefings with service leadership, and through involvement in service decision-making bodies such as the Aircraft and Weapons Board (AWB).

Despite these initial steps, the goal of constructing air warfare as a research domain had yet to be realized. Bowles's rhetoric and Weaver's ideas provided a framework for defining the enterprise. But it still remained to establish a more precise intellectual road map and specific practices to turn this vision into a resource and tool for the Project. By training and inclination RAND's engineers, the bulk of the staff, did not actively engage this institutional problem. Rather, John Williams, colleague of Warren Weaver during the war and head of RAND's "Evaluation of Military Worth" section, would take the initiative.

Williams was one of the quintessential RAND personalities. Like Bowles and Arnold, he had strong feelings on the dangers of the postwar world and the need to prepare for the possibility of future war. Speaking of the war years, he recalled that he "became very much alarmed at the mass of characters that were loose in the world and decided that there was no one standing between me and these people except the United States armed forces. Then I decided that if I didn't somehow *participate* I'd have only myself to blame if I didn't like the way it turned out."[17] His view of the postwar period was much the same. At the invitation of Collbohm, he joined RAND soon after it was established, seeing in the new organization an opportunity to contribute to national preparedness. Collbohm had

17. Vaughn Bornet, "Interview: John Williams: A Personal Reminiscence," August 1962, RAND Publication D-19036, p. 4.

worked with Williams on an AMP project toward the end of the war (perhaps as part of Collbohm's advisory activities with Bowles) and was impressed with Williams's skill and enthusiasm. With a comic acknowledgment of Williams's intellectual nimbleness, Warren Weaver recommended him for the RAND position by offering he "was the laziest man that he had ever met and therefore could be relied on to find an easy way to solve hard problems." But Williams's greatest asset was a facility for stepping outside his own academic training to draw other disciplines into the RAND enterprise of studying modern air warfare. Like Weaver in his work at Rockefeller, Williams saw the problems of modern war and the research domain they defined as primary. The goal was to adapt and reconstitute traditional disciplines to contribute to an analysis and understanding of this new field of investigation.

Williams's primary academic training was in theoretical astronomy, but just before the war he had gone to Princeton to study mathematics. He left before completing his degree to give himself over to the war effort. Through his wartime experience, mathematics and its application to military problems became his professional focus. During the war, he developed an ecumenical view of how to approach military problems. He headed the AMP's "Statistical Research Group of Princeton at Columbia," dealing with operations research problems of the battlefield. At Columbia, Williams was in contact with economists and sociologists as well as fellow mathematician John Von Neumann, who was also attached to the AMP and finishing his and Oskar Morgenstern's seminal *Economic Behavior and the Theory of Games*. Williams left the war with views similar to those expressed by Weaver in his "Comments on a General Theory of Air Warfare." Mathematics could provide a descriptive, quantitative model of air warfare, serving as a framework to organize and express the contributions of other disciplines in understanding modern war. And perhaps most important, given the "mass of characters...loose in the world," Williams believed in the need to diminish uncertainty and introduce rigor into national decision making.

Within days of arriving at RAND as the project's first mathematician in early June 1946, Williams began to elaborate Weaver's and his own ideas on military worth. In a note to Frank Collbohm, Williams offered that "to be unique RAND must recognize the necessity of trying to develop objective methods for evaluating proposals; indeed, that this is a prerequisite to a campaign of proposals from RAND."[18] Williams, though, readily saw the difficulty of defining such objective methods. Mathematical modelling and quantification probably would be inadequate for analyzing the myriad variables that composed the prospective domain of air warfare.

> In such a fantastically difficult problem, the only reasonable expectation is that the attempt will end in failure; one should anticipate that certain important elements of the theory of warfare cannot even be quantized, or that possible values of some important elements cannot even be assigned a rank or order. But in the course of failing to attain the general objective, it is very likely that substantial parts of the problem will be solved, and for the first time; so failure in the absolute sense is nothing to worry about. Incidentally, complexity of problem is not sufficient reason for failure, if the components are understood; complexity affects only the time needed to bring it to a given stage of completeness.[19]

18. Memorandum Williams to Collbohm, 6 June 1946, RAND Publication D-7, p. 1.

19. Ibid.

But quantification of the political, social, and technological aspects of warfare was only part of the problem of developing objective methods. The particulars of RAND's brief history also mattered. RAND's location in the Douglas Aircraft Company and its status as a contractor of the Army Air Forces might affect the new project's ability to define the research domain of air warfare. The RAND contract itself, Williams noted, by specifying study on "intercontinental warfare other than surface" introduced a limitation on the research enterprise that was grounded in interservice rivalries with the Army and Navy. Douglas, too, as an engineering and business organization brought an outlook and experience that might constrain the research enterprise. The perceptions and interests of Douglas and the service might conflict with that of RAND's professional staff. All of this, Williams offered, "is something RAND is going to have to live with for some time."[20] The best approach as a matter of politics and education was to discuss with service leadership directly the boundaries and content of the field.

Of greater concern to Williams in summer 1946 was the limited number of disciplines represented on RAND's staff. If RAND was to articulate a general theory of warfare it would need to add new disciplines to its core of engineering and science expertise. Williams argued this would be a "formidable problem...the first for RAND to solve. In organizing a group, one should have no illusion that pertinent fields of inquiry can with safety be elided from the study, simply because they are difficult to include."[21] The difficulty Williams alluded to was possible

20. Ibid., p. 2.

21. Ibid., p 3.

reactions from Douglas and the Army Air Forces. Mixed research teams examining military problems had made their debut during the war in various operations research groups. Williams and Weaver had participated in such activity as part of the work of the AMP. But the broader mandate of the RAND enterprise to explore the postwar boundary between the civilian and the military--which Bowles and Williams interpreted in different ways--promised a more pervasive involvement in service decision making and culture. The prospect of analyses of military life grounded in economics, sociology, or psychology might well be resisted by service leadership.

Williams saw these potential difficulties in implementing a broad, professionally-defined research program on air warfare as challenges to be overcome. For Williams and others at RAND there really was no alternative path. They accepted the powerful arguments advanced by Arnold and his successors in the Army Air Forces on preparedness and the centrality of the air arm in fighting the next war. Arthur Raymond encapsulated the sense of urgency and mission that permeated the organization in summer 1946: "The peace of the world is dependent upon the peace-loving nations. It is a Pax Americana. This country must `tread softly but carry a big stick'. We are concerned in RAND with the physical `big stick'."[22] Raymond's comments, made in the wake of RAND's satellite study, reflected the deep interest in the guided missile as a defining technology of the next war. But it also implied the challenge of defining new decision-making and social

22. A.E. Raymond, J.R. Goldstein, July 1946, RAND Work Outline, Rand Publication RAD-1, p. 1.

structures for responding to the demands of the postwar world. For Williams this meant that "we needed just about every facet of human knowledge to apply to problems of the kind we were about to face, and therefore that we should staff RAND in that manner and with that perception."[23]

During the summer 1946 through fall 1947 Williams proceeded to evaluate the twin problems of defining a military worth program as outlined by Weaver and building up the requisite disciplinary skills at RAND. Williams began to compose a small group for this purpose. In August 1946 he brought as consultants Princeton's S.S. Wilks (a specialist in statistics); Stanford's W.Allen Wallis (economics) and Herbert Goldhamer (sociology); Leo Rosten (sociology); and, of course, Warren Weaver. He also recruited for the RAND staff mathematicians Olaf Helmer and Frederick Mosteller. Williams and Weaver had become acquainted with most of these men through the wartime AMP. The group's initial task was to compose possible lists of personnel who might be willing to serve as "consultants, subcontractors, or full members of RAND."[24] They developed a list of more than

23. Bornet, "Interview: John Williams," note 17, p. 19.

24. J. Williams, "Summary of Conferences of Military Worth (July 25, 26, August 2)," 6 August 1946, p. 1, RAND Publication RAD-17. Helmer and Mosteller had worked with Williams on the AMP during the war. Helmer's interest in the Weaver-Williams concept of military worth was reinforced by his own training and professional interests. He received a doctorate in mathematics from the University of Berlin in 1934. Soon after, he emigrated to the U.S., working as a research assistant to Rudolf Carnap at the University of Chicago as well as maintaining friendly ties to Hans Riechenbach (a professor of Helmer's in Berlin) at UCLA. Reichenbach was a consultant at RAND during this period, undoubtedly recruited by his old student. Through these contacts, Helmer was deeply influenced by the "unity of science" movement initiated by Carnap and the Vienna Circle. The military worth program seemed, to Helmer, a practical extension of this enterprise. On Helmer's background and views see O. Helmer, Oral History Interview, March 1994, RAND History Project, NASM. On the history of the unity of the sciences movement see Peter Galison and David J. Stump, *The Disunity of Science: Boundaries, Contexts, and Power* (Stanford: Stanford University

thirty prospects in the nation's major universities, research centers, and foundations, covering fields as diverse as history, agricultural economics, anthropology, demography, and geography, as well as those expertises represented in Williams's small working group.

Williams was not directly concerned with the specific theoretical foundations in any of these disciplines or whether one rival school of thought was preferred over another. He had no grounding in or extended experience with the disciplines he sought to align with the RAND effort.[25] The goal was to begin to be able to understand and attach values to those myriad variables that Weaver's general theory implied. Economics, sociology, and the other disciplines would provide data inputs that the mathematicians would interrelate and weigh through appropriate functions. Williams held an optimistic faith in rationalism. As he organized his efforts on comprehending the interrelations among new weapons, military institutions, and society his optimistic approach was "to get some thinkers together. Then if they could discover any rational things to do, and stated them,

Press, 1996). Leo Rosten brought more unusual credentials to the enterprise. At the same time he consulted at RAND he was employed in Hollywood as a script writer. Later he published the best-selling *Joys of Yiddish*.

25. Weaver, though, was perhaps more familiar with developments in the social sciences. The Rockefeller Foundation, Weaver's employer, was the largest funder of social science research in the country from 1924-1940, helping to establish the Social Science Research Council, a national organization and planning body for the field's many disciplines. The foundation's goal was to encourage integration of these disciplines. On this see Donald Fisher, *Fundamental Development of the Social Sciences: Rockefeller Philanthropy and the United States Social Science Research Council* (Ann Arbor: University of Michigan Press, 1993).

other intelligent men of good will would see that they were rational and useful and profitable--and they might even adopt them."[26]

Williams aspiration to recruit the social sciences for the project may have seemed improbable. His own lack of knowledge in this area, the novelty of incorporating these disciplinary perspectives into military and corporate decision making, ambiguity over the long-term stability of the project, and the fact that his appeal to academics came under the auspices of an aircraft manufacturer were hurdles to overcome as Williams sought recruits. But he approached his challenge with zeal. He encountered skepticism from anthropologist Margaret Mead when she was asked to participate in the project. Williams recalled "the shocked look on [her] face one day when, having come down from Vermont to meet me in a Boston hotel...she learned that working for RAND involved working for the Douglas Aircraft Co."[27] Nonetheless, Mead agreed to consult for RAND. And others followed.

Perhaps it was partly the unorthodox appeal of the salesmen. Rosten recalled his first meeting with Williams and Collbohm: "In walked this odd combination: Frank Collbohm looking like a lean, leathery, weather-beaten sailor; and of course, John--waddling in--weighing at least 280 pounds, no tie, short sleeves, messed hair, etc."[28] But more likely RAND's appeal to these professionals lay

26. Bornet, "Interview: John Williams," note 17, p. 20.

27. Bornet, "Interview: John Williams," note 17, p. 34.

28. B. Haydon, "Interview with Leo Rosten," 1971, RAND Publication IN-21355-1, p. 3.

elsewhere. As with many "hard" scientists there was a belief in, or at least sympathy with, prevailing ideologies of preparedness. Moreover, as in physics and other disciplines more directly associated with weapons development, social scientists viewed the possibility of support from the military and business more favorably as foundation funding diminished. These issues soon would come into sharper focus when, in September 1947, Williams would organize a Conference of Social Scientists as a crucial step in building a program of study on military worth.

As Williams and company considered problems of recruitment through 1946 and mid 1947 they also tried to translate Weaver's general analysis of air war into a concrete program. A series of meetings and exchange of memos among the group in December 1946 and January 1947 highlighted the difficulties of the enterprise. Beginning a study of military worth involved both defining the domain of research and pinpointing specific problems that might be investigated. Moreover, Williams was concerned that the group's emerging definition of the field might conflict with LeMay's and Bowles's expectations for the project--with respect to the suitability of including the social sciences and to the proper bounds of the research effort. As Williams had noted earlier the focus on air war might impose artificial limitations on the research effort. While all agreed on the value of incorporating sociology, political science, economics, and psychology into the field, they differed on the extent to which these disciplines should inform the definition of the research undertaking. In addition to awareness of RAND's political context, members of Williams's group differed over technical concerns, such as the sophistication of the mathematical tools at their disposal and the contributions to be expected from the "soft" sciences--particularly whether and how these contributions might be quantified and correlated with physical variables as called for in Weaver's general theory. These concerns, in combination with the uncertainty over whether RAND would continue beyond its two-year authorization, resulted in a rough consensus that the first steps should be to identify particular problems for investigation but, as Williams put it, "to have a frame of reference which adequately encompasses the subject matter [but] the complexity of the subject is almost boundless...."[29]

By late January Williams, in concert with the group, had prepared a list of twenty-five possible specific studies. Most derived from the suggestion of Samuel Wilks that "the most logical place to focus...attention would be on the theaters of military operations--the real 'cutting edge' of the war where weapons are applied to targets."[30] The contribution of economics, say, might enter into such a framework through analyzing targets to be selected, concepts of damage to an enemy economy, or the effects on the military establishment and national economy of particular programs of weapon development and manufacture. Wilk's analysis rested on assumptions that were congenial to service thinking in which notions of "weapons" and "targets" were thought to be reasonably well understood. Economics and other disciplines would simply provide a richer analysis of an agreed upon approach to warfare. Williams and Weaver could accept this as a starting point.

29. J. Williams, "Program for the Evaluation Section of Project RAND," 20 January 1947, p. 1, RAND Publication RAD-76.

30. Samuel Wilks, "Weapon-Target Coverage Analysis..." 4 December 1946, p. 1, RAND Publication RAD-79, Appendix A.

But Olaf Helmer argued for studies that allowed sociologists, economists, psychologists, and political scientists to define the problems in their own way. Political scientists, he offered, might, for example, view the problem of target selection in terms of "the political set-up and distribution of political power, the identity of persons or groups now in power or rising to power, or the decentralization of command within the armed forces"--rather than in terms of industries and transportation facilities as was the case in World War II.[31]

Williams's list of studies more closely followed Wilks's than Helmer's analysis, which Williams dubbed the "conservative" and "not conservative" views, respectively. A substantial fraction of the list identified research projects concerned with components of Wilks's weapon-target problem. Possible projects included "alternative vehicles," vulnerability of United States and Soviet targets, the "coverage problem" (identifying the probability of desired destruction given the uncertainty of bomb distribution within a target area), and others. But a few of Helmer's interests also were incorporated, such as "Russian diplomatic behavior" and "Russian morale and susceptibility to panic of the population."[32] All were considered components that could fit into a more general theory of air war. The list was just a start to generate methods of analysis and, more especially, to begin the massive process of data collection that the Weaver model implied. The sifting,

31. Olaf Helmer, "Recommendations Concerning the Participation of Social Scientists in RAND," 10 December 1946, p. 2, RAND Publication RAD-79, Appendix D.

32. Williams, "Program for the Evaluation Section of Project RAND," 20 January 1947, note 21, p. 3.

correlation, and analysis of such data would be the basis for arriving at the indices of military worth which were the end product of Weaver's general theory and Williams's project at RAND.[33]

Williams, both directly and through Arthur Raymond (Douglas Vice President of Engineering and Research and the company's lead on the RAND contract), was in touch with Bowles and Georges Doriot, the Harvard Business School professor and former Army Quartermaster whom Bowles was seeking to place as RAND's director and as his liaison with the RAND Advisory Council. Both Bowles and Doriot seemed to find merit in Williams's prospective list of research initiatives and its use as a tool to recruit new disciplines to RAND. LeMay, too, was willing to support this kind of endeavor within RAND. While LeMay was more concerned with the development of weapons, particularly the guided missile, Williams's military worth enterprise was a conceptual cousin to the rhetoric of Arnold and Bowles on the service's role in responding to the new era of warfare. A central part of the argument of preparedness was that war was a struggle of society against society. A practical implication was that new and varied professional skills would be drawn into the effort to prepare for future war.

33. Indeed, one of Williams's suggested projects was a study of how to define meaningful indices of military worth--that is, to explore how the kinds of questions Helmer raised could be represented in quantifiable terms or assigned numerical values. Williams brought in Abraham Kaplan, a logical positivist philosopher from UCLA, to address this problem. Kaplan reported to Williams on his efforts in memo from Abraham Kaplan to J.D. Williams, "On the Study of Military and Other Types of Worth," 17 July 1947, Folder "Misc. Letter...and Memorandum from A. Kaplan," Box 7, E.L. Bowles Papers, NASM.

This view was reinforced by the prevailing prescription of strategic bombing articulated by Arnold during the war, in which the goal was the destruction of vital economic assets and of an enemy's will to resist. This notion invited a closer analysis of strategic bombing doctrine through the lenses of economics (a step which had already occurred during World War II), political science, and psychology. Williams recalled visiting LeMay in 1946 or 1947 with some trepidation to make the pitch for his military worth ideas. LeMay, in Williams's account, endorsed the effort without reservation.[34] These expressions of support were apparently useful in persuading Arthur Raymond, who was more skeptical as to how such activity would fit into the Douglas Aircraft's interest in relating RAND to product development. Williams noted that "at a cost of some blood on the wall in the Douglas Company, we have obtained approval to offer serious inducements to the persons on the list in an effort to get them to devote themselves to novel but interesting careers."[35]

It is not clear how actively Williams pursued recruits in early 1947. The goal was to build up a "home team" to conduct research and coordinate the work of numerous academic consultants. Williams, though, seemed to adopt a suggestion by Helmer that RAND organize a conference of social scientists "to give them a briefing, to discuss jointly the outlines of the research program, and to raise

34. Bornet, "Interview: John Williams," note 17, p. 22-24.

35. John Williams, "Subjective Account of the December Meetings...," 28 January 1947, p. 3, RAND Publication RAD-79.

morale by demonstrating that this is a collective effort."[36] The conference itself would provide an opportunity to recruit new disciplines into RAND. Through the summer of 1947 Williams and his group worked to arrange a meeting to take place in New York in September.

By August 1947 Raymond had become a supporter of the application of social sciences to the military enterprise. As part of the regular quarterly briefings between RAND and the Air Staff, he highlighted the upcoming meeting, the program for which had been approved by the service. Raymond offered that the "purpose of the meeting...is to determine in the various social science fields what should be studied, by whom, where, and to obtain what results. In going at this one question we ask ourselves, and it is basic, is 'What is our national purpose? Our real national purpose, our real military purpose in the larger sense, of trying to maintain the peace or to win a war if it comes'...."[37] Raymond's sense of RAND's mission was a tall order for a two-year contract project at an aircraft manufacturer.

The broad charter Raymond identified for RAND reflected the fact that there was no visible, organized analytic effort to address the large questions of preparing for the kind of war that Arnold, Bowles, and many others envisioned. The service operations research offices, such as the Navy's Operation Evaluation Group,

36. Helmer, "Recommendations Concerning the Participation of Social Scientists in RAND," note 31, p. 2.

37. Arthur Raymond, "Presentation of Mr. Arthur Raymond on Project RAND," 13 August 1947, p. 10, RAND Publication RAD-188.

developed programs of research more tightly defined by problems of immediate concern. The Joint Research and Development Board (JRDB), and its successor, the RDB were designed to coordinate and evaluate ongoing and proposed military projects. They did not have a direct charge to examine the larger issues of social organization and political economy embedded in the concept of thorough-going preparedness in time of peace. In late 1948, with the urging of Vannevar Bush, the RDB and the Joint Chiefs of Staff, did establish under their joint auspices the Weapons Systems Evaluation Group (WSEG). But WSEG which also addressed the complex questions of interrelating strategy, war plans, and weapons, would not conceive its domain of research as broadly as RAND.

Indeed, Weaver, in a wide-ranging think-piece prepared for Williams several months earlier as part of the initiation of a study on air defense of the United States noted this situation with frustration. Like the study of the intercontinental bombing mission, the air defense question was "intimately related to the social, economic, and political structure of our country and to our foreign policy." Either the service should limit RAND's scope of responsibility, Weaver argued, or RAND should be the nucleus of a newly created national planning group that would embrace all of the military establishment. In the absence of such sound government organization, Weaver thought, "RAND is forced, by circumstances, to approximate [this] kind of approach to its job" and "they have the paradox of trying to run, under AAF contract, a sort of scientific-industrialist-economist-political scientists-Army-Navy-State Department-White House job from Santa Monica, under the auspices of three or four aircraft companies, and with no dependable assurance of continuity."[38]

Raymond's and Weaver's thoughts on the breadth of the RAND enterprise, thus, were indicative of an odd phenomena. In the first years after the war there was an institutional vacuum for assessing the implications of preparedness. Building on the ideas and organizational changes initiated by Arnold and Bowles and the recruitment of like-minded professionals such as Williams, RAND stepped into this void. The pivotal questions of the service's role in and the nation's response to the demands of modern war were being taken up by this new organization, novel in its relation to the service, that in turn was hoping to recruit scholars whose ability to contribute was as yet unproven.

The conference held in New York over 14-19 September revealed the breadth of ambition of the military worth idea and the practical limitations of its execution through RAND. Weaver, as one of the principal organizers of and inspirations for the conference, presented the opening address. His challenge, he believed, was to explain to the conference members why "in God's sweet name" they should gather, work, and articulate research problems under the auspices of the newly established Department of the Air Force and of an aircraft manufacturer.[39] Weaver offered first that all the participants as professionals shared a commitment to a "rational life." And as citizens "every person in this room is desperately dedicated to the

38. Warren Weaver, "Active Air Defense of the United States," 21 March 1947, RAND Publication RAD 106.

39. Warren Weaver, "Opening Remarks...," p. 3, Folder "Conference of Social Scientists," Box 1, E.L. Bowles Papers, NASM.

ideals of democracy and...wants to do everything he possibly can in the furtherance of those ideals."[40] Weaver knew his audience was aware of increased tensions between the United States and the Soviet Union, resulting from confrontations over Iran and Turkey in summer 1946, and Greece in spring 1947. President Truman had begun to sharpen United States policy through his enunciation of the Truman Doctrine and the start of the Marshall Plan. Given these recent events, all of the participants, Weaver ventured, were concerned about the state of the world and "all of us would most desperately like to do something about that if we possibly could."[41]

Such commonalities were a starting point. But Weaver also invoked his experience in developing the biological sciences at the Rockefeller Foundation and with operations research during the war. The possible conjunction of RAND, the Air Force, and the social sciences was, in Weaver's view, an example of ways in which recent American political culture fostered collaborations among government, professions, and business. Such collaborations were a "typical element of American strength."[42] And this proposed collaboration, while perhaps "a funny

40. Ibid., p. 5.

41. Ibid.

42. Historian Peter Novick has noted that in the postwar years in political and academic discourse many professionals assumed a strong correlation between American political culture and research practices that strove for objectivity. Free political institutions facilitated independent inquiry, especially in universities. This was to be contrasted with totalitarian states such as the Soviet Union, where political ideology intruded on scientific methods and professional canons for conducting research. The first approach elevated the empirical and objective in research; the latter introduced relativism and moral ambiguity. Novick argues that this was one rationale used by United States academics, particularly sociologists but including historians, to conduct research in support of the Cold War. Weaver's comments here and below can be seen in this light. See Peter Novick, *That Noble Dream: The "Objectivity Question" and the American Historical Profession* (Cambridge,

way to work at" the conundrums of modern war and peace, reflected changes in the conduct of warfare. War and the preparations for defense had "become an oppressively technical and complicated business." Echoing the language of Hap Arnold, Bowles, and others, Weaver noted that:

> A lot of distinctions that used to hold no longer hold. The distinction between the military and the civilian in modern war, is...a negligible distinction. Modern war is obviously between whole populations...It may even be, for example, that the distinction between war and peace has gone by the board.[43]

The collapse of such distinctions signaled a situation in which all citizens and all knowledge were continually part of national defense.

This transformation had stimulated the military, in a departure from prewar practices, Weaver noted, to seek closer working relationships with academia and industry, "to accept and want to accept a type of partnership with civilians and a type of partnership with competence wherever they find it." As proof, Weaver cited the forceful endorsement of this ethic in Eisenhower's 1946 policy paper "Scientific and Technological Resources as Military Assets," written by Bowles. Equally important, though, was that new institutional arrangements had made such collaborations concrete, especially in the area of military and weapons planning. And this Weaver noted was:

> ...pretty near the critical question. They [the military] were quite willing to accept civilians on a certain service level in the past. They used to say "We like to have you around, and if you are awfully smart we will ask you questions and you will answer them as well as you can; but then we

Eng.: Cambridge University Press):281-319.

43. Weaver, "Opening Remarks...," note 39, p. 4.

> will go into another room and shut the door and make our decision." That, in the past they were quite willing to do. Now, however, they want us in the back room with them. They want to talk over the really fundamental questions, and they are actually admitting civilians at the planning level. That, I think, is very significant.[44]

This outline of the merging of the military and the civilian and of a closer collaboration in planning was merely preamble for Weaver. What did all this mean for academic disciplines, particularly for the social sciences?

> ...we get nowhere in the world as it is organized and run today--we get nowhere in the problems of defense--nowhere in the problem of maintaining our country at that level of living which we wish to maintain--unless we pool all of our resources....I think this brings upon a large number of intellectual enterprises a thoroughly healthy pressure...that results in drawing together and amalgamating a large number of intellectual enterprises which in the past have by no means been isolated but which I think have not been drawn together as they should in the future...in particular, the whole fields of the social sciences and of the physical sciences must be brought more closely together.[45]

Such collaboration could be modelled, Weaver offered, like operations research during the war, especially as conducted by the British, through the use of "mixed teams" of social and physical scientists.

But the important point was that in the present context both sets of disciplines should assist in defining a new discipline--the study of modern war and its unique demands on American society. Weaver saw this problem as one that might be reduced to a study of weapons and targets. But even within this apparently narrower domain of inquiry, Weaver argued, we would need "every piece of knowledge that we have...every piece of knowledge we have in sociology and in eco-

44. *Conference of Social Scientists*, September 1947, p. 5, RAND Publication R-106.

45. Weaver, "Opening Remarks...," note 39, p. 5-6.

nomics and in political science...every thing we know about social psychology...everything we know about enemy morale." While Weaver felt that mathematics and its tools would provide a crucial means for illuminating the "organized complexity" of modern war, he also recognized that analytic techniques would confront "whole areas in the social science before which they would stand baffled." Collaboration was required because as in the past war "...you have to get answers...It isn't like some problems which are academic in the pejorative sense. *You have to get the answer.* You have got to do something. You have got to act, wisely or foolishly." Working together would provide, Weaver thought, "something quite obviously greater than the sum of its parts."[46]

With this introduction the conference began its work. Attendees were organized into five committees, reflecting the thinking of Williams and his consultants in the preceding months. Three were designed to represent the major disciplinary perspectives: Committee on Psychological Studies and Sociological Studies; Committee on Political Studies; and Committee on Economic Studies. Two reflected the efforts of William's group to integrate these disciplines into a comprehensive study of warfare: Committee on Military Policy and Committee on Research Methods, Organization, and Planning. Williams's staff and consultants were integral parts of the conference. The academic community was well represented. Chicago sociologist William Ogburn, who championed empirical and

46. Ibid., pp.6-7. Historians, too, would hear such exhortations. Conyer Read's 1949 presidential address to the American Historical Society employed similar language: "Total war, whether hot or cold, enlists everyone to assume his part. The historian is no freer from this obligation than the physicist." Cited in Novick, *That Noble Dream*, note 42, p. 318.

statistical methods, headed the committee in his subject matter. Political scientist Harold Lasswell, an exponent of applying scientific methods in his field, also came from Chicago to chair the Committee on Political Studies. Jacob Viner, another prominent empiricist, headed the Committee on Economic Studies. Academic representation was weighted toward those who found the methods of science congenial and had worked to apply them in their own fields.[47]

Each committee was organized into a series of panels charged with addressing questions and issues that might form the nucleus of a research project.[48] Wil-

47. On the move toward empiricism, statistics, and the application of scientific methods in sociology, economics, and political science in the 1920 and 1930s see Dorothy Ross, *The Origins of American Social Science* (Cambridge, Eng.: Cambridge University Press, 1991). Ogburn and Lasswell were particularly active in this regard and were instrumental in establishing Chicago as a center for empiricism in the social sciences. Ogburn also directed the preparation of *Recent Social Trends*, a study commissioned by President Herbert Hoover in 1929 and published just before Hoover left office. This provided Ogburn with his first opportunity to apply his research perspective to national policy making; it was also one of the first instances in which social scientists were brought into policy making by a president. Laswell's involvement with RAND seemed particularly ironic. In 1941, Laswell had advanced the hypothesis that the rise to political power of "specialists in violence" threatened to create a series of totalitarian "garrison states." In the postwar period, with the ascendancy of the military in United States life, some commentators wondered whether this country was headed toward the same end. Lasswell's participation in the conference and afterward as a consultant to RAND was apparently justified as a means to expand interest group access to military power thus opening the closed processes of decision making associated with the "garrison state." On Lasswell see Harold Laswell, "The Garrison State," *The American Journal of Sociology* 46 (1941):455-468; and Arnold A. Rogow, ed., *Politics, Personality, and Social Science: Essays in Honor of Harold D. Lasswell* (Chicago: University of Chicago Press, 1969).

48. The panels for the various committees were as follows: Committee on Psychological and Sociological Studies: Aggression and Morale; Attitudes and Opinions; Political Psychology; Committee on Political Studies: Elite-Mass Relations; International Relations; Committee on Economic Studies: International Economic Relations; Internal Economic Conditions; Economics of Preparedness and War; Committee on Military Policy: Intelligence and Information; Military Affairs; Committee on Methods, Organization, and Planning of Research: Research Methods; Organization and Utilization of Research. The final panel was ad hoc, providing an opportunity to review project ideas generated during the con-

liams's group had prepared approximately one hundred of these topics in advance. The work of the panels was pragmatic. Each assessed whether the topic as presented or with modification was worthy of research; if so suggestions were made on who and what institutions might implement it and the personnel and funds required. The expectation of Williams was not that RAND would undertake all these research projects. Rather, through the work of the conference, RAND would recruit a small nucleus of social scientists and implement studies that were not or could not be done elsewhere. Universities, the State Department, and the fledgling UNESCO were variously suggested to carry out studies or provide data from work underway. RAND would also serve to coordinate and bring together research results that might emerge from such a multi-institutional effort.

Williams organized the conference in a way that mirrored his military worth endeavor. The broad domain of modern warfare was broken down into a series of discrete problems as represented in the tasks of the conference panels. Data from research, if pursued in the fashion envisioned, would provide the input for a general theory of military worth and for arriving at specific measures for the value of national and military choices in preparing for and conducting future war. But exactly who would make these choices was left unclear. This was a critical dif-

ference which did not fit the planning framework. Each panel then assessed a series of proposed projects. For example, under the Political Psychology Panel projects reviewed included "Cultural Backgrounds of Decision Making," "Elite Psychology of Surrender," "Psychological and Political Factors in Russian Foreign Policy," Psychological Peacefare," and "Soviet Diplomatic Techniques." As these panels and projects suggest the research agenda was crafted to follow the assumptions of preparedness and the doctrine of strategic bombing.

ference between the military worth strategy and that of Bowles. Bowles's conception of postwar society included the creation of a management class (a collaboration between the Air Staff and aircraft industry leaders) that would implement decisions and policies in preparing for future war. The military worth approach, as an intellectual activity only loosely connected to service leadership and unconnected to national political leadership, raised the problem of how the knowledge it might generate would be translated to managers and political leaders. Indeed, this problem was the subject of one of the conference's panels.

The answer to this question, in part, had been broached earlier by Williams; he posited a community with a shared view of rationality in which researchers could communicate findings and persuade military leadership. Weaver had followed the same line in his introductory remarks to the conference, noting how the recent war had helped to change expectations and remake institutional relations between scientific communities and the military. This had been Bowles's and Arnold's objective in establishing RAND. Weaver correctly saw that such institutional integration was prerequisite for his and William's program of military worth.

But the broad scope of the military worth agenda, even if prospective research was fruitful and access to the back room easy, only emphasized the challenge of connecting political and military leaders with the community of researchers investigating the military domain. For example, Ogburn headed a panel on "Economics of Preparedness and War." He identified a problem that was at the heart of the idea of sudden and total war: "all social institutions have to be mobilized." The question was how this would be realized in conditions of peace and in war. In each case, fundamental changes might well be required in the "economic order and in political institutions," and these changes needed to be studied. He noted that this "integration of war and social institutions" (brought about principally by "the invention of the airplane and the invention of certain types of high-powered explosives") made it "peculiarly the province of the advice of social scientists." Ogburn foresaw modest measures, such as a careful plan of stockpiling strategic materials, as well as more radical possibilities such as modifying market capitalism and developing plans for rapid movement of citizens away from urban areas. The goal was to study and plan for policies that addressed the possibilities of modern war as well as the sociological "resistances" that such changes might provoke. Ogburn's reflections were directed at national political leadership. "If speed [in the preparation for war] is of the essence, then planning is of the essence, and if planning is to be done successfully, the responsibility for it must be clearly set."[49] While this scale of analysis and call for action was entailed in the Williams's military worth agenda, as a practical matter Ogburn's insights went considerably beyond RAND's own mandate.

As Ogburn's reflections suggest, the conference captured the prevailing sense that a profound recasting of basic social and political assumptions was underway. Modern war, thus conceived, seemed to offer intellectual explorations and profes-

49. All quotes from "Committee III, Panel 8," *Supplement to Conference Book Conference of Social Scientists, September 14-19, 1947*, Folder "Supplement ...," Box 1, E.L. Bowles Papers, NASM.

sional opportunities for the social sciences. The conference occurred at a time of anxiety over funding. Williams's success in attracting an accomplished cross-section of the social science community was probably influenced by the interest of these professionals, as with their natural science colleagues, in garnering federal support. By fall 1947 social scientists, as represented by the Social Science Research Council (SSRC), had been frustrated in their attempts to secure a place, and hence funding, in the proposed National Science Foundation (NSF).[50] Williams and some of his consultants had worked with the SSRC and its Executive Director Donald Young in organizing the conference, with the thought that RAND might play a role in directly or indirectly supporting social science research. But the possibility of military funding raised cautions among some members of the SSRC. Invited to contribute opening remarks to the conference, Young appealed for open minds on the part of the attendees. He noted:

> That I have been asked to talk briefly about the relation between Project RAND and the social sciences suggests that there are those who think that the relationship may not be fruitful or even that it may be nefarious...within the past week a very distinguished social scientist remarked in my presence that he thought it was scandalous that the Army Air Force[s] through the Douglas Aircraft Company and Project RAND should be so deeply involved in research in the social sciences.[51]

50. The Social Science Research Council had been founded in 1923 as a national umbrella organization for professional societies of anthropologists, economists, historians, political scientists, psychologists, sociologists, and statisticians. On the council and its role in seeking postwar federal funding for social science, see Samuel Z. Klausner and Victor M. Lidz, eds., *The Nationalization of the Social Sciences* (Philadelphia: University of Pennsylvania Press, 1986), chapter 1.

51. Donald Young, "Remarks," *Supplement to Conference Book Conference of Social Scientists, September 14-19, 1947*, Folder "Supplement ...," Box 1, E.L. Bowles Papers, NASM. In remarks after the conference Williams noted that he was concerned that some of the participants would consider the whole exercise "war mongering" but the "attitude of the social scientists in New York was much better than we hoped it would be." These concerns may well have led to the invitation to Donald Young to address the conference. Williams comments in "Conference at Home of Mr. Leo Rosten," 7 October 1947, unfoldered, Box 17, Brownlee Haydon Papers, RAND.

One concern, as in other areas of research, was whether military funding might recast the research basis of the social sciences. Another closely related concern, glossed over by Weaver, was that nearly all of RAND's research was classified. Weaver's portrayal of the military worth enterprise suggested initiating a new field of scientific inquiry in academia. All that was required, in Weaver's view, was for the social and physical sciences to join in defining and studying a new research domain. But such inquiry, because of the classified character of the work, would be conducted under conditions significantly different from traditional academic work. Young did not directly address these questions. Nevertheless, with a hint of defensiveness, he disagreed with the assessment that such research was "scandalous." Instead Young, speaking as a member of the SSRC Board of Directors, saw RAND as, potentially, a crucial facilitator for the social sciences. The project offered a broad research plan, an interest in interdisciplinary cooperation, a conduit for moving research from the academic domain to the solution of problems of national interest, and as "free [a] hand as possible to social scientists in obtaining their cooperation." All these, Young claimed, the community needed if it was to gain the confidence of the public and of patrons. But equally important, given the frustration over the NSF legislation and SSRC concern over the availability of funding, was a simple fact: "We need money....My reply to the man who said it was scandalous that such a large project in the social sciences was being operated under air forces auspices is that we have no organization in the social sciences which could do it."[52] But because of the challenges of organizing the social sciences within RAND itself over the next two years, the project never did fill this catalytic role as a funder and organizer of these disciplines on a national scale.

The conference marked a turning point for Williams's military worth enterprise. For RAND the immediate results of the conference were modest. The conference succeeded in meeting one of Williams's primary goals: the hiring of staff for RAND. Economist Charles Hitch, an Oxford don and known to Williams from attending the same undergraduate university in Arizona, and sociologist Hans Speier, a German emigre then situated at the New School for Social Research in New York City, joined RAND after their participation in the conference. They would be charged with organizing research programs in their respective fields, much of it building on the work of the conference. However, on joining RAND in 1948 they established their own departments within the organization and did not work under Williams. This is noteworthy. The military worth concept emphasized mathematical modelling as a means to organize and manipulate the research inputs of other disciplines. This implied that Williams's mathematical group should oversee and coordinate the work of RAND's various departments and subunits--which as noted above did not happen. RAND's emerging research departments, which will be discussed later, were more or less equals in the life of the organization.

52. Young, "Remarks," note 51. Young went on to add that the goal of the community should be to seek a diversity of support: military, nonmilitary government, business, and private philanthropy. This balance of support would help insure the integrity of the research enterprise.

Williams had no particular administrative ambitions; his interests were more in the intellectual challenge of elucidating Weaver's original idea of a general theory of air war and to rouse others to take it seriously, too. Hitch and Speier had sufficient work to staff their departments, establish research agendas, and to tie their work to RAND's technical studies without trying to fit their efforts to Williams's program of quantification and determination of value of military worth. Soon after the arrival of Hitch and Speier, Williams's department was renamed Mathematics and became a focus for specialized research in new areas of applied mathematics. Williams remained an intellectual catalyst in the organization. With these changes Williams's trusted band of consultants moved on to other work at RAND or ended their contracts. Weaver also gradually reduced his involvement in RAND's activities, perhaps feeling he had contributed as much as he could.

Williams's and Weaver's conception of a program of military worth was recast as these changes took place. Their program focused on a goal that was not much in demand: to construct a comprehensive theory and methodology for correlating and evaluating specific data, such as characteristics of airplane and engine types, radars, anti-aircraft rockets, and many other weapons, as well as the productivity of national economies, military budgets, war aims, and strategy--and then to arrive at simple indices of whether one set of values or another for these variables would optimize the chances for winning a hypothetical war. Williams, in a clipped note to himself, stated "Interim [intercontinental bombing studies] plus Satellite projects, and others, tie into M.W. [military worth] project--all really one coordinated program, although it may appear otherwise now. Projects furnish *numbers*, intelligence, other sources furnish facts, then M.W. puts all in hopper and hopes to furnish relative evaluations....job is tremendous, and will take best brains and much time and effort."[53] But Williams's notion of a general theory was so comprehensive that it was difficult to translate readily into a program of research. More important, perhaps, was that a military worth program, in this form, inchoate and overly ambitious, emphasizing comparative evaluations on a grand scale, was not directed at the immediate problems (such as selection of a new long-distance heavy bomber or the best manner in which to conduct an attack on the Soviet Union) of the independent Air Force. Useful answers might be years away.[54] A less grand approach was required, retaining the organizing ideas of Weaver and Williams but emphasizing problems of more manageable scale.

Military Worth and the Organization of Research at RAND

William's and Weaver's military worth enterprise fundamentally shaped RAND's organization and program of research. The idea that air warfare constituted a domain for organized investigation became central to RAND. This domain included not only weapons as applied in war but also the Air Force, in its

53. John Williams, "Military Worth," summer 1947, Unfoldered, Box 17, Brownlee Haydon Papers, RAND.

54. Williams was aware of the elusiveness of his task. Helmer, for example, reported after a trip to the economics department at Stanford that they "expressed little hope for the construction of a meaningful National Security Index...[but were] much in favor of having some time during the summer devoted to the problem of measuring military worth and national security, if only in order to clarify the basic difficulties involved and to have people aware of these difficulties." Memo from O. Helmer to J. Williams, "Trip to Stanford," 4 January 1948, Folder "Incoming Memos, Jan-Mar 1949, F.R. Collbohm Papers, RAND.

organization, politics, place in American life, strategy, and technologies. Their efforts resulted in the recruitment of specific disciplines to RAND. The social sciences, particularly economics and political science, as represented by Hitch and Speier, respectively, were, the most dramatic inclusion. Within a year of the conference Collbohm and Raymond settled on an organizational structure composed of divisions reflecting academic and technical specialties specific to the interests of the service. In addition to Hitch's and Speier's units patterned after traditional academic departments, there were divisions for missiles, nuclear energy, aircraft, electronics, and mathematics. RAND leadership envisioned these divisions as loci for specialized research and data collection and as resources for each other.

The interconnection among the military worth concept, organization, and personnel can be seen in the following figures. Figure 3 provides a summary of the disciplines represented at RAND for personnel, some subcontractors, and consultants in early 1949. Staff expertise was most heavily concentrated in physics, engineering, mathematics, and computation, with an initial buildup in economics and the social sciences--usually understood at RAND to include sociology, political science, and psychology. The project's transition, discussed below, to a non-profit corporation in November 1948 facilitated the recruitment of professionals in these latter areas. By 1950 the number of staff increased incrementally and through the 1950s would expand significantly (Figures 4 and 5).[55] Through the 1950s, though,

55. Figure 3 from *U.S. Air Force Project RAND Third Annual Report*, 1 March 1949, RAND Publication R-134, p. 3; Figure 4 from *Project RAND Fifth Annual Report*, 1 March 1951, RAND Publication R-215, p. 9; Figure 5 from "Histogram of RAND Departmental Growth," 29 January 1971, RAND Publication IN-21355-1, p. 3.

Figure 3: RAND Professional Staff, 1949

Source: RAND Publication R-134.

	RAND Staff	Professional Service Sub-contractors	Other Sub-contractors	Con-sultants
By Classification:				
Aerodynamicists	9	1		
Astronomers	1			1
Chemists	5			1
Physicists	26	1		8
Economists	5	13		6
Political Scientists	4	3		2
Psychologists	1	1		2
Other Social Scientists	4	9		2
Mathematicians	44	7		4
Logicians	2	1		
Statisticians	8	1		
Engineers	47	2		
Computers	25			
Publications Staff	22			
Technical and Non-technical Services	95	2		
Total	298	41	—	26
By Education:				
Ph.D.'s	38	30	16	22
Masters	42	5	12	4
Bachelors	92	6	42	
Technical, No Degree	21		18	
Nontechnical	105		37	
Total	298	41*	125†	26‡

*Mostly university personnel working regularly part time on RAND.

†Some of the employes of these subcontractors work only part time for RAND. This number represents the equivalent of full time employes.

‡Mostly university personnel retained on the usual consulting basis, with compensation based on work actually performed.

Figure 4: RAND Professional Staff, 1951

Source: RAND Publication R-215.

APPENDIX II

RAND PERSONNEL

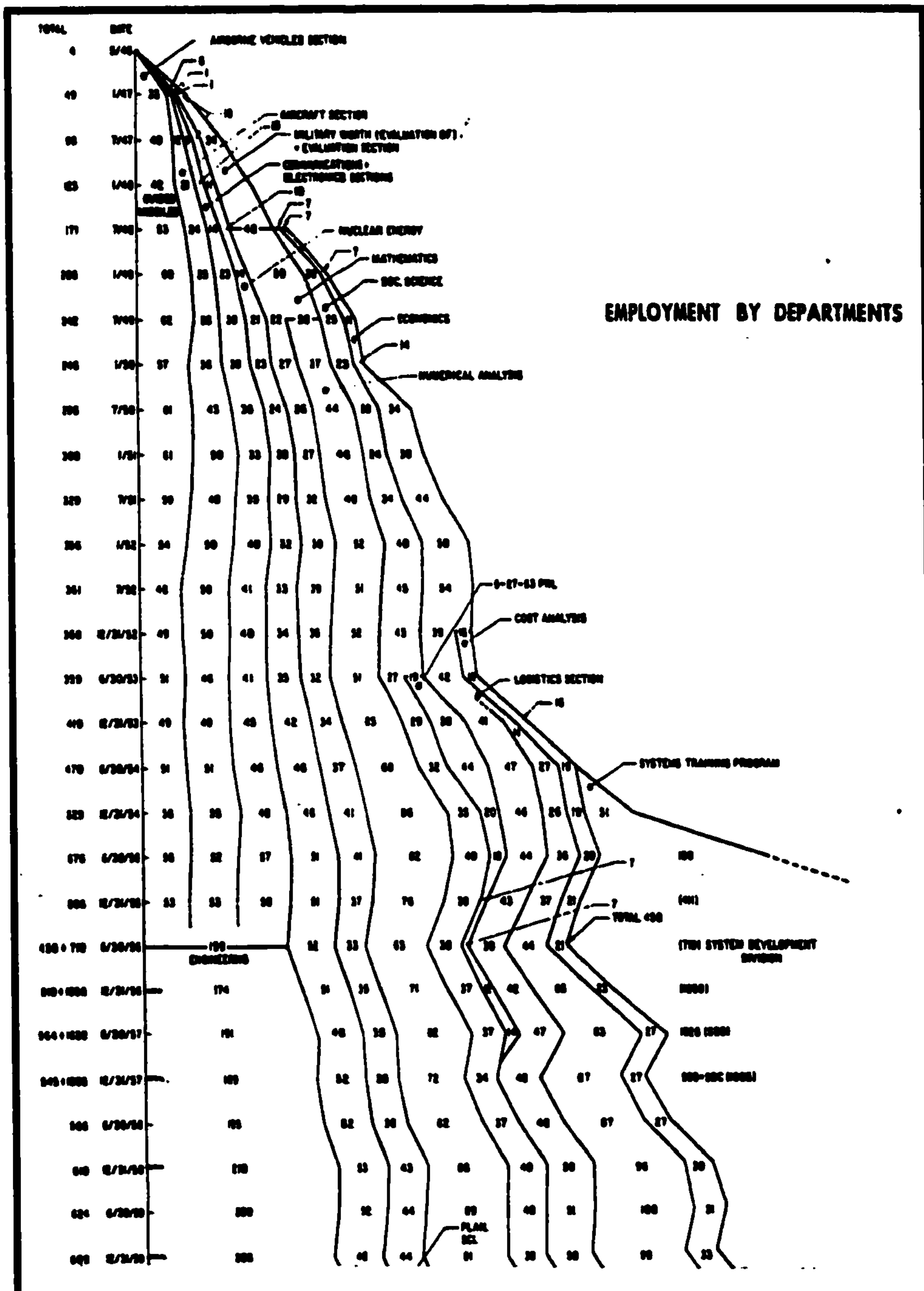
PERSONNEL SUMMARY

March 1, 1951

	RAND Staff	Professional Service Contracts	Consultants
SPECIALIZATION			
Aerodynamicists	8	1	
Astronomers	1		
Chemists	2		
Computers	40		
Economists	23	17	16
Engineers	86	6	2
Logicians	3		
Mathematicians	51	8	10
Social scientists (other than listed)	5	2	1
Physicists	36	5	12
Political scientists	6	5	4
Psychologists	2	1	1
Publications staff	20		
Sociologists	4	2	2
Statisticians	7		5
Technical and nontechnical services	136	1	5
TOTAL	430	48	58

Figure 5: RAND Staffing Trends by Departments, 1946-1959

Source: RAND Publication IN-21355-1.



RAND's Social Science Department was split between Santa Monica and Washington, D.C., with the bulk of the staff in the east. Many of the department's political scientists and sociologists preferred readier access to academic circles in the east and to government policy makers.

Figure 6, from early 1948, suggests how technical personnel were distributed in the organization before the buildup of the social science and economics at RAND.[56] Figure 7, from March 1948, adds a "human sciences" section; Figure 8 shows RAND's organization in 1950 after two years of operation as a corporation, with separate divisions for economics and social sciences equal in status with the others.[57] Both Figures 6 and 7 highlight the integral part RAND's industry subcontractors and consultants played in the early conception of the organization--they were representative of the cross-institutional nature of the project and of a collective effort to study the domain of intercontinental warfare.

In the center of Figure 7 stand the activities that united these individual and institutional contributions--systems analysis, time phasing of plans, and task force studies. Systems analysis referred to the application of these various expertises, with particular emphasis on mathematics and modelling, and of sources of data to particular broad problems. The result of a systems analysis, ideally, would be the

56. This figure is from an early draft of RAND's second annual report, untitled, 1 February 1948, Folder "Project RAND 1948," L. Ridenour Papers, University of Illinois Archives.

57. Figure 7 from *Project RAND Second Annual Report*, 1 March 1948, RAND Publication RA 15075, p. 6; Figure 8 from Folder "Board of Trustees Reference Materials," RAND.

Figure 6: RAND Draft Organization Chart, 1948

Source: L. Ridenour Papers.

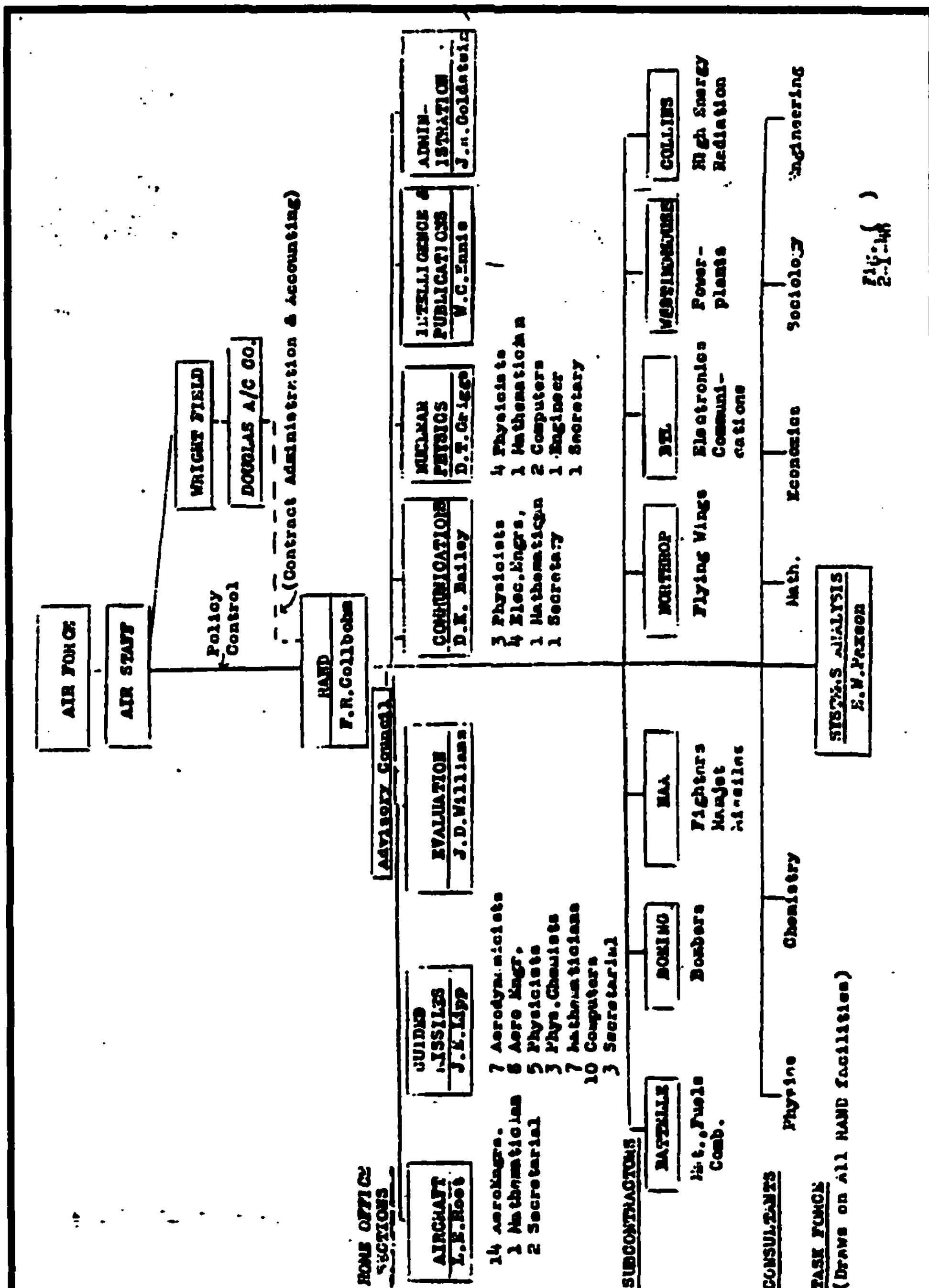


Figure 7: RAND Organization, 1948

Source: RAND Publication RA-15075.

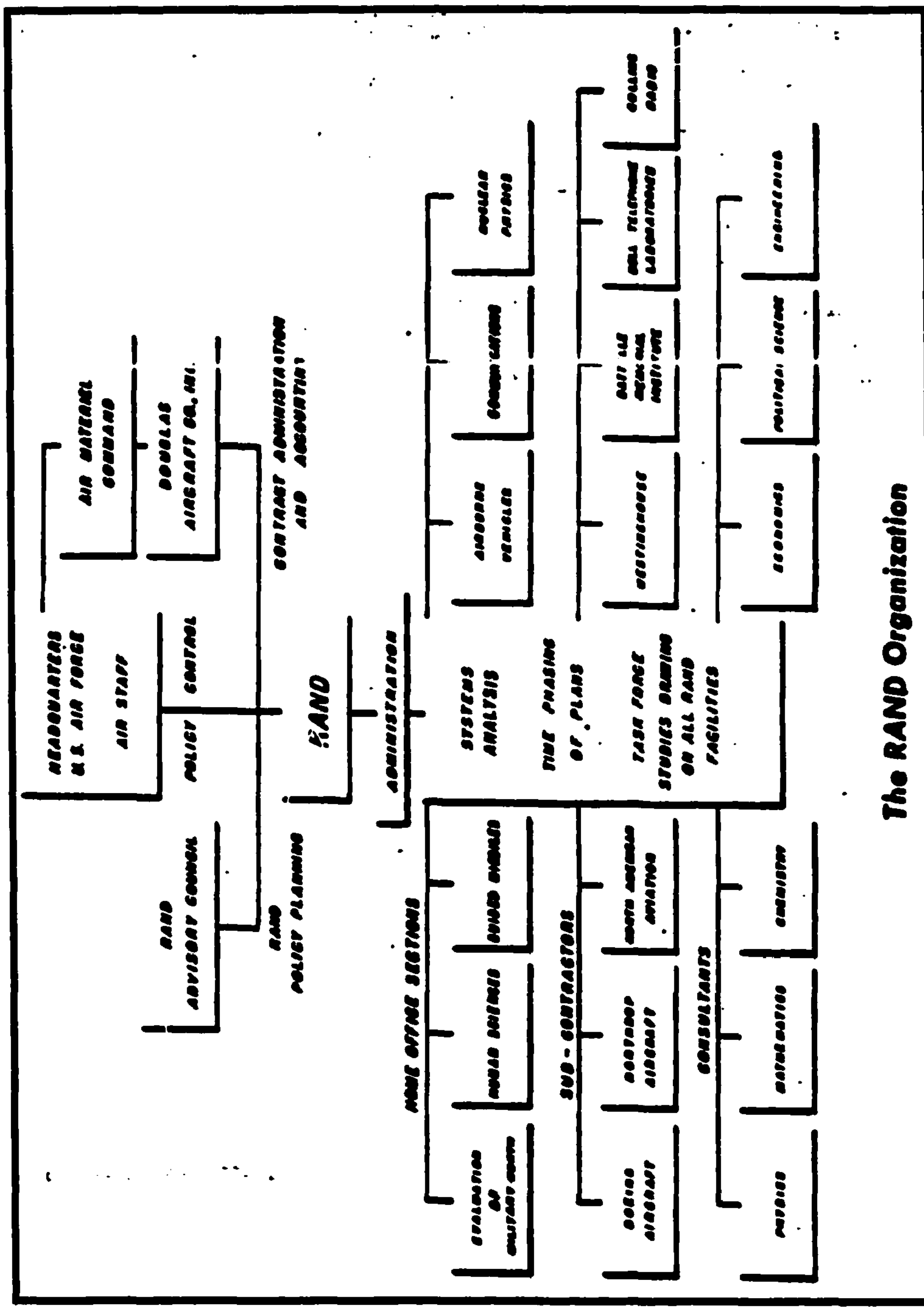
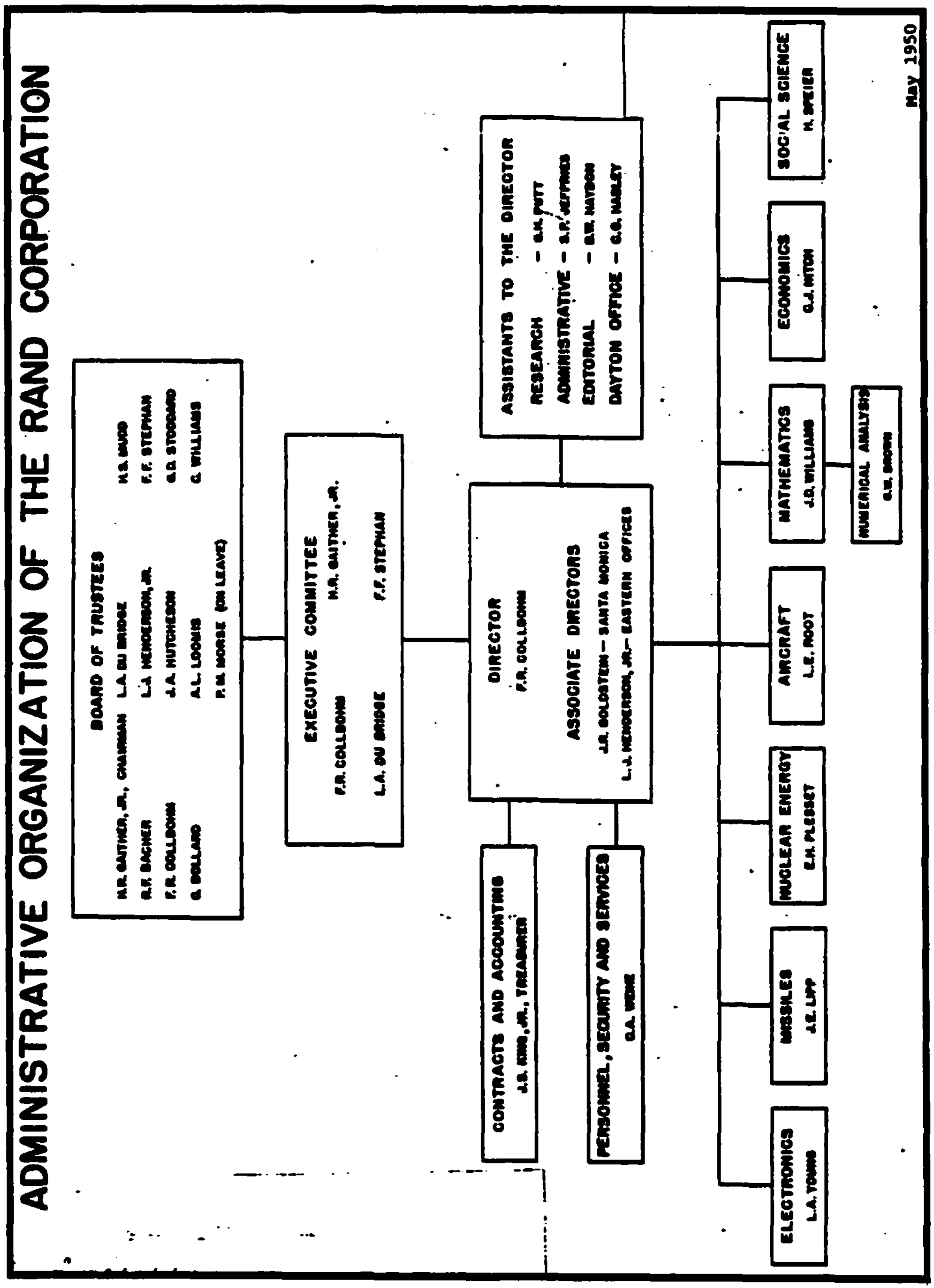


Figure 8: RAND Organization, 1950

Source: Board of Trustees Materials, RAND.



proper definition of a problem, assessment of data, and, through mathematical modelling, a weighted set of choices--as envisioned by Williams and Weaver. Systems analysis was a pragmatic offshoot of the ambitious concept of military worth. Williams and Weaver seemed to aim at modelling the whole scope of modern war--from technologies, strategies, and institutions to national resources. Systems analysis addressed problems of narrower but still complex scope. This was a necessary step to define problems that could be researched effectively and that correlated with key decisions confronting the Air Force. At this time RAND had underway two major studies: analyses of intercontinental bombing and air defense of the United States.[58]

Time phasing referred to the ongoing process of mutually adapting research, development, and production of weapons with budgets, composition of the force, and strategy--a recognition of the need to actively manage the interconnections among technology, military planning, and politics. Technology was perceived, by RAND staff and military leadership, as the driver, and so the timing of its availability would affect the other elements of planning. These terms of art, applied to problems of such organizational complexity and expense as inter-continental warfare and air defense, were, as Weaver noted earlier, "intimately related to the social, economic, and political structure of our country and to our foreign policy." Figure 9 offers an outline of how RAND management saw the

58. The intercontinental bombing study will be examined in detail in the next chapter.

process of carrying out the sets of interrelated activities associated with systems analysis.[59]

In addition to shaping RAND's organization and sense of mission, military worth and air warfare as a research domain defined the problem choices and interests of the disciplines at RAND. For example, from 1947 through the early 1950s, RAND staff mathematicians and consultants conducted the most active research program in the country in various branches of applied mathematics--particularly game theory, linear programming, and dynamic programming--subjects which at the time were of little interest to academia. John Von Neumann, as a consultant, actively assisted Williams and the RAND mathematics staff in cultivating the application of game theory to military problems. Richard Bellmann and George Dantzig (developers, respectively of linear and dynamic programming) found a congenial home at RAND for exploring their interests in applied mathematics. All these fields pertained to solving for maximum or minimum values functions of many variables--the basic mathematical problem of the military worth endeavor. All were pursued with the thought that at least some parts of the research domain could be mathematically modelled. The military worth concept also implied a massive data collection and manipulation effort. Williams soon organized an ongoing program to push the state of the art in computer hardware and programming. This led in the early 1950s to a collaboration with Von Neumann to develop at

59. Figure 9 is from draft RAND second annual report, 1 February 1948, note 56.

Figure 9: "Spectrum of RAND Activities," 1948

Source: L. Ridenour Papers.

THE SPECTRUM OF RAND ACTIVITIES

- 35 -

Long Range	Military Worth ⇄	Systems Analysis	⇄ Components
Program	Development of analytical methods for determining worth of all actions, strategies, tactics, and weapons in the broadest sense.	Determination of the comparative cost and efficiency of all combinations of weapons and carrier vehicles which can now be foreseen.	Search for the capabilities and limitations of all conceivable applications of developments in physical science, social science, and technology.
Facilities	Evaluation Section Consultants Collaboration of University Groups	Task Force drawing on all of RAND Air Combat Room Collaboration of Air Force	All sections of RAND All subcontractors All consultants Cooperation of Military
Typical Developments	Conference of Social Scientists	Too early to report	Long Range Rocket Design Factors Nuclear Energy manifestations XXXXXXXXXXXXXXXX Supersonic aircraft New Materials
Shorter Range	Military Worth ⇄	Systems Analysis	⇄ Components
Program	Refinement of mathematical tools; construction of mechanical aids to the solution of complex problems.	Determination of cost and efficiency of bombing systems now in development.	Search for improvement in present weapons and vehicles of aerial warfare.
Facilities	Same as above	Same as above	Same as above
Typical Results	Target Coverage Machine Random Digit Generator Slide Rule Functions Computing Bureau	Outline of Method (see Quarterly Reports) Air Combat Room Answers due in 6 mos.	Voluminous topical reports on airplanes, combustion, electronics, fuels, guided missiles, high energy radiation, materials, nuclear energy, rockets, the satellite. (This comprises the bulk of RAND results to date)

RAND the Johnniac computer (named after Von Neumann), making RAND also a national center for advances in computing and programming.[60]

In the engineering and science fields, as Figure 9 suggests (see column 3), work was concentrated on investigating the myriad component elements associated with intercontinental bombing, air defense, or the development of rockets and satellites: long-range bomber design; jet and turbo-jet engines; aerial refueling; studies of fighter-bomber duels; enemy air defenses; radars; bomb size; interrelations among bomber speed, altitude, and target; upper atmosphere research; rocket engines, propellants, and structural materials; missile guidance; and much more. RAND's quarterly and annual reports, as a way to demonstrate the project's productivity, listed most of its studies. In the first two years RAND published nearly one hundred reports, heavily weighted in content toward mathematics, science, and engineering.[61]

The emerging social science research agenda also took its cue from the military worth concept and, particularly, the problems surrounding the intercontinental bombing mission. Arnold's definition of strategic bombing as an attack on economic assets and on an enemy's will to resist served as a point of departure for many of the social science studies through the early 1950s. Hans Speier, head of

60. The best overview of RAND's work in mathematics is Bruno Augenstein, *A Brief History of RAND's Mathematics Department and Some of Its Accomplishments*, 1993, RAND Publication DRU-218-RC.

61. A list of these publications is in *Project RAND: Second Annual Report*, 1 March 1948, RAND Publication RA-15075.

the social science division, was a specialist in the response of communities and political leadership to propaganda and the trauma of war. One of his first studies, from 1948-1950, was on the behavior of enemy populations when provided with advance warning of imminent aerial bombardment. Nathan Leites, a political scientist, established his reputation in these same years for his well-known study *The Operational Code of the Politburo*, an examination of Soviet leadership and how they might respond to economic and political pressures as well as their behavior during war. Leites's study was rigidly behavioral in argument, suggesting that for any given stimulus one could precisely predict the Soviet reaction. One of his conclusions, perhaps not surprising, was that eliminating Soviet leadership, because of its absolute control of political power, would be crucial in achieving surrender during war.[62]

Such studies tried to give rigor and precision to plans for fighting a war with the Soviet Union. These and other analyses also helped to make concrete Weaver's and Williams's ideas that all knowledge needed to be integrated into planning for modern war--and that all knowledge might be used as instruments, weapons even, to affect the adversary. The work of the RAND social science group was part of a broader trend within the individual services, the Joint Chiefs, and State Department to explore the uses of what was called psychological or unconventional warfare. In 1951 President Truman established the Psychological

62. Nathan Leites, *The Operational Code of the Politburo* (New York: McGraw-Hill, 1951).

Strategy Board to coordinate much of this activity.[63]

Weaver suggested earlier that the boundaries between the military and the civilian and between war and peace had been erased. Within RAND and the Air Force this insight expanded into the idea that any bit of knowledge might prove decisive within the commodious framework of modern war. At times, these could lead to almost comical prognostications. With the 1948 Berlin crisis as backdrop, Frank Collbohm met with General Orville Anderson of Air Force Plans in July to discuss RAND social science research, particularly Nathan Leites's Soviet study. Anderson was rethinking his assumptions on warfare and on objectives and desired outcomes from possible conflict, as were many others in service leadership. Reflecting on Soviet political culture and the insights of Leites's study, Anderson offered that he saw "a super vulnerability there [the Soviet Union] that calls for an entirely new technique, even a new weapon....I believe your analysis will show that there is an iron curtain around this nation that in terms of characteristics properly diagnosed and his [the Soviet Union's] concentrated vulnerability might be more easily cracked than our own." Collbohm agreed and suggested that the techniques of social science might replace conventional and atomic weapons: the

63. The literature on history of the social sciences in the early Cold War is scant. See Charles Thomas O'Connell, "Social Structure and Science: Soviet Studies at Harvard" (Ph.D. diss., UCLA, 1990); Samuel Z. Klausner and Victor M. Lidz, eds., *The Nationalization of the Social Sciences*, note 50; Allan A. Needell, "`Truth is Our Weapon': Project Troy, Political Warfare, and Government-Academic Relations in the National Security State," *Diplomatic History 17* (1993):399-420; and on the related field of area studies see Bruce Cumings, "Boundary Displacement: Area Studies and International Studies During and After the Cold War," in *Universities and Empire: Money and Politics in the Social Sciences During the Cold War* (New York: The New Press, 1998):159-188.

"signs are already pretty clear. World War III if it doesn't start too soon is going to show the next [weapon] is non-physical science, the social science, psychology, things like that will be decisive." Anderson saw even more extravagant promise in developing such untraditional weapons courtesy of the social sciences: "I can take Good Housekeeping or Woman's Home Journal and use it as a weapon and take it and knock them on their ear." The general never suggested how specifically such periodicals might be tailored to undo the Politburo. Collbohm concluded the discussion: "We are getting there, weapons of that nature now, so it is just a matter of time as I see it."[64]

Economic studies, similarly, defined their research domain with reference to precepts of strategic bombing doctrine. In 1948, through a request from the Joint Chiefs of Staff, RAND initiated a series of studies to examine the economic war potential of the Soviet Union and to compare this with United States capabilities.[65]

64. All quotes from Dictaphone Cylinder Transcription, F.R. Collbohm, General Anderson, and Others, 19 July 1948, "Re: RAND Work," pp. 43-45, Folder "Dictaphone Transcriptions, 1948," F.R. Collbohm Papers, RAND. Consideration of unconventional weapons was a component of the Social Science Division's research program and a particular interest of its head, Hans Speier. As suggested by Collbohm's and Anderson's discussion the ideas on this subject could be quite freewheeling. For example, a 1949 gathering of RAND staff and consultants considered the seemingly silly possibility of using mass hypnosis to create social chaos, as well as "systematic, scientific" assassination. One participant noted there might be some difficulty with such a course of action: "Would Congress appropriate money?" See Minutes "Conference on Discussion on Novel Strategies and Weapons," 5 August 1949, Folder "Miscellaneous, 1949" J.R. Goldstein Papers, RAND.

65. The request came from the Joint Intelligence Committee, Joint Chiefs of Staff. The RDB would examine the research and development aspects of Soviet capability; the RAND economics staff the comparative potentials of the U.S. and USSR economies. See Memo from J. Phillips, Office of the Air Force Secretary, to Director of Research and Development, DC/S Materiel, 18 February 1948, Folder "380 Projects, 1948, Vol. 3," Box 817, Series 1, RG 18, NARA. On the challenges of conducting this research see Memo from C.J. Hitch to H.R. Gaither, 13 April 49, Folder "Incoming Memos, April-June 1949," F.R. Collbohm Papers,

This led to assessments of Soviet and United States manpower, labor productivity, mineral and fuel resources, structure of capital investments, munitions production, the economic contributions of ally states, and other topics. Another focus of research was economic implications of target selection--of urban populations, centers of political authority, of critical industrial assets--to determine which targets might be decisive in war. Such studies built on related analyses done during World War II (in which RAND's Charles Hitch had been involved) to assess the strategic bombing campaigns in Europe and Japan, but now the subject had to be rethought in light of the evolving Cold War situation and the availability of atomic weapons. This work, in the early 1950s, would lead to RAND's critique of military plans for fighting nuclear war, the research area for which the corporation would become most well known.[66]

Weaver's and Williams's notion of a general theory of air warfare, by drawing together different disciplines to study a common domain, suggested a collegiality of interest among research groups and institutions. This was supposed to be the ideal within RAND, often evident more in corporate pronouncements than in practice. This call to collegiality also extended to external relations. Since its inception RAND had an active informal and formal intercourse with the service--through research trips to bases and commands and through regularly planned brief-

RAND.

66. For a summary of RAND's initial research in economics see *U.S. Air Force Project RAND Staff Report*, 1 September 1948, RAND Publication R-103, pp. 65-69.

ings with the Air Staff and the Air Material Command, the service entity responsible for procuring research, development, and manufactured weapons. But this kind of interchange quickly included industry, through the program of RAND subcontracts, and academia, through university consulting agreements, both mentioned earlier.

After unification in September 1947, RAND staff were active in establishing contacts with the numerous government agencies comprising the national security effort--particularly in those areas in which RAND had or would quickly develop distinctive expertise: the study of the intercontinental bombing mission, rocket and satellite technology, soviet studies, atomic weapons effects, selected subfields of sociology and economics, and areas of mathematics outlined above. In the late 1940s RAND staff established contacts throughout the government bureaucracy--with the RDB, the Joints Chiefs of Staff, the WSEG, and the Navy in the military establishment and the Atomic Energy Commission (AEC), the Bureau of the Budget, the National Bureau of Standards, and the State Department elsewhere in the government. These contacts took the form of research working relationships, participation in boards, testimony, consulting arrangements, and exchanges of personnel.

RAND was quickly recognized as one of the leading centers for integrating social science perspectives into the military effort. Speier was a member of the RDB Human Resources Panel (the entity responsible for assessing the services projects in the social sciences) and chair of its subpanel on Psychological Warfare.[67] He also was detailed to the State Department on a part-time basis to consult on programs in psychological warfare and on political studies on Europe. Speier and his staff also had active connections to the new university centers of Russian studies, such as the Harvard Russian Research Center.[68] As noted earlier, Charles Hitch and the RAND Economics Division were asked by the Joint Chiefs of Staff, as part of the development of war plans for fighting the Soviet Union, to undertake a study of the economies of the United States and U.S.S.R. to determine their relative capabilities to support varying levels of war effort. David Griggs, Head of RAND's Physics Division and a wartime consultant under Bowles, and his successor Ernest Plesset, established close working relationships with the Atomic Energy Commission (AEC) and the Armed Forces Special Weapons Project (a joint-service group charged with assembling and providing atomic weapons to field commanders). This would lead in 1950 to a separate contract from the AEC to support RAND's studies on the technology and effects of atomic weapons.[69] All of these

67. The RDB Human Resources Committee was established in January 1947 and considered issues of manpower, troop, morale, and training as well as capabilities in psychological warfare. On Speier's and RAND's contributions to the panel and subpanel see, for example, Memorandum J. Goldsen to Staff, "Summary of RDB Report," 6 September 1949, Folder "Incoming Memos, July-Sept 1949," F.R. Collbohm Papers, RAND.

68. For a partial account of Speier's work at State on psychological warfare see Needell, "Project Troy," note 63; on connections to Harvard see O'Connell, "Social Structure and Science," note 63.

69. On the close working relationships among RAND, the AEC, and the Armed Forces Special Weapons Project, see, for example, memo from J. Whiteley, Executive Office, DC/S Operations, USAF, to Chairman, AEC, 28 July 1948, Folder "380 Projects, Jan-Oct 1948, Vol. 4," Box 817, Series 1, RG 18, NARA; and D.L. Putt, Director, Research and Development, to Chief, Armed Forces Special Weapons Project, 14 September 1948, Folder "380 Projects, Jan-Oct 1948, Vol. 5," Box 817, Series 1, RG 18, NARA.

activities were an outgrowth of Weaver's and Williams's concept of military worth, reflecting a wide-ranging appetite for access, data, and institutional perspectives that would help create a shared understanding of the military as a domain of research.

A schematic (Figure 10) entitled "RAND in the National Defense Effort," from a draft annual report, suggests how RAND viewed itself as a nexus for interrelating the contributions of the military, academia, and industry.[70] For a time, RAND and the Air Force promoted this depiction. To RAND, the image suggested their creativeness in attempting to make a science out of the sobering problems of the Cold War. To the Air Force the image bolstered their sense of managerial nimbleness, in comparison to the Army and Navy, in adapting to modern war. In 1950, after the start of the Korean War, *Fortune* magazine writer John McDonald approached RAND and the Air Force on preparing a feature on the corporation. They obliged and provided McDonald with extensive access to RAND staff. RAND even stretched the rules of security classification. McDonald had no security clearances but RAND nonetheless shared insights into its work that, under usual procedures, would not have been available to him. The result was a very laudatory article on RAND and its role in the Air Force. In one of the article's graphics (Figure 11) McDonald shared with the reading public the same image of the corporation found in RAND's classified annual reports.[71] Such images later shaped public perceptions of the corporation as a "think tank."

70. Figure 10 is from draft RAND second annual report, 1 February 1948, note 56.

71. John McDonald, "The War of Wits," *Fortune* (March 1951):3-11. RAND, with the Air Force's consent, made McDonald a consultant, qualifying him for a temporary clearance and, thereby, access to classified data. In turn, McDonald

Figure 10: RAND in the National Defense Effort, 1948

Source: L. Ridenour Papers.

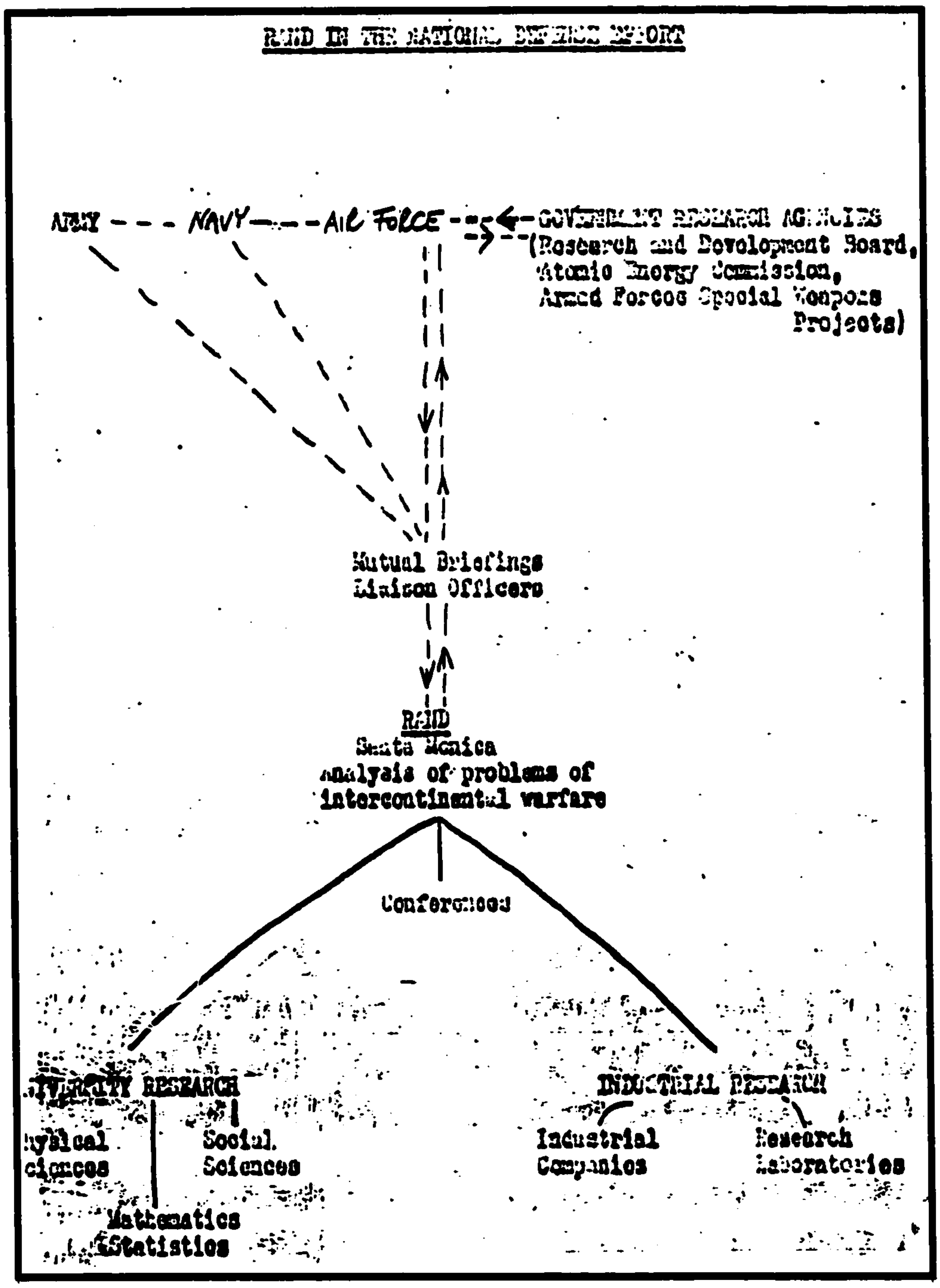
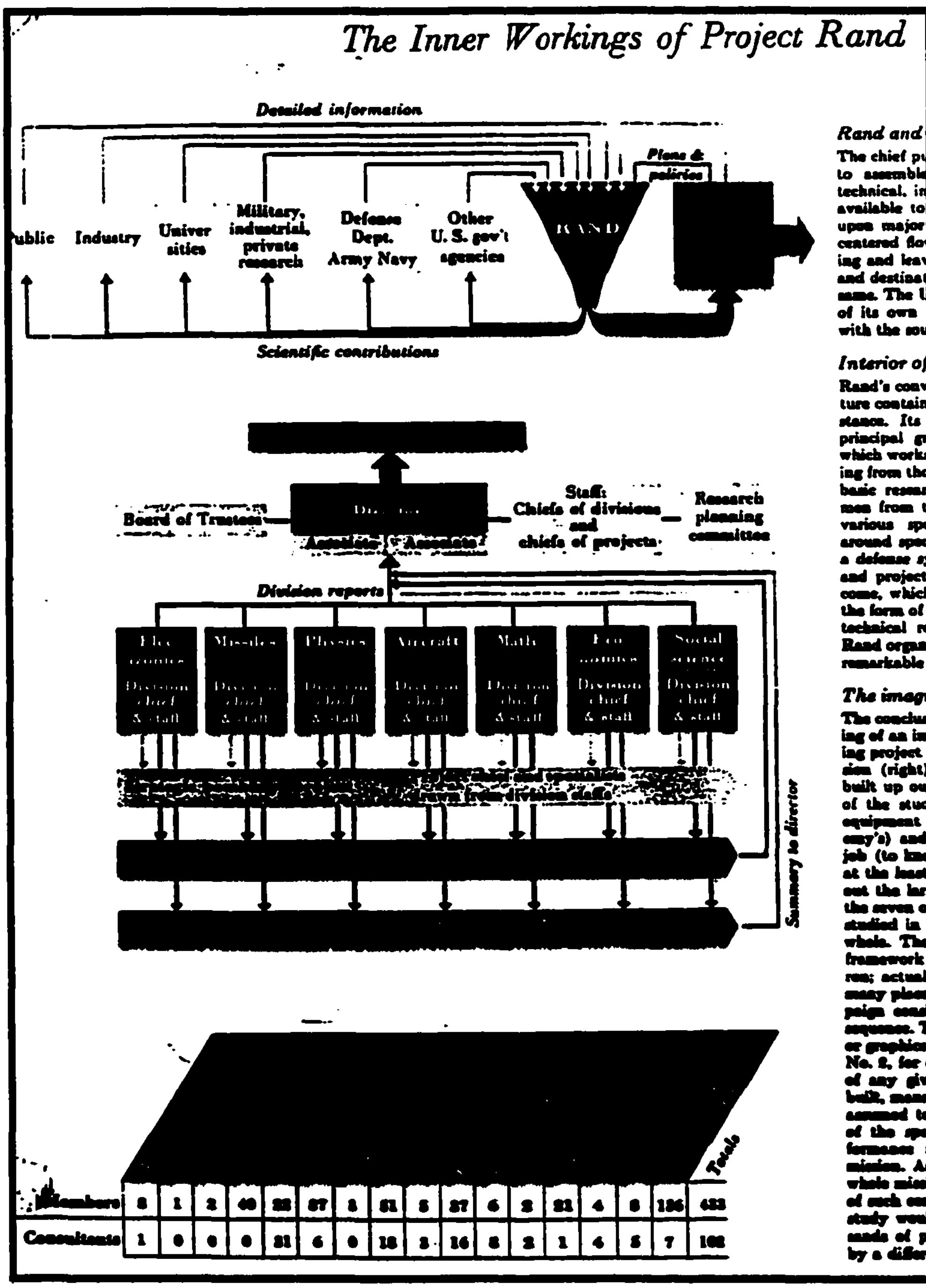


Figure 11: "Inner Workings Project RAND," 1951

Source: <u>Fortune.</u>



This pattern of contacts was amplified through RAND's practice in these early years of hosting summer studies in Santa Monica. For example, in summer 1948 Edwin Paxson, a mathematician on Williams's staff and leader of the RAND systems analysis on intercontinental bombing systems, organized a colloquium on the "Theory of Planning in Relation to National Security," as a forum for RAND staff, university consultants, officers from the Air Comptroller (the service unit responsibility for developing service budgets and programs), and others. Paxson's interest in planning was an offshoot of the underlying ideas of military worth and of his leading role on the systems analysis. A theory of planning would provide a larger conceptual framework for justifying working assumptions used in individual systems analyses that might be affected by national political, budgetary, and economic conditions. In the case of the strategic bombing systems analysis Paxson had to make assumptions on levels of congressional military funding and on how the Air Force would allocate its budget in support of an air campaign against the Soviet Union. As with decision making on the choice of bombers and strategy for intercontinental warfare, here was another area of military responsibility which required specific actions--the making of plans--and was inextricably bound with larger questions of politics. The July meeting examined four aspects of military

and his editors promised not to publish any classified information and agreed that the Air Force had final approval of the article. See memo from J.R. Goldstein to F. Collbohm, 14 July 1950, Folder "Outgoing Memos, July-Dec 1950," J.R. Goldstein Papers, RAND, and letter from DCS/Development G. Saville to F.R Collbohm, 21 September 1950, Folder "095 RAND Corp (1950)," Series 160, RG 341, NARA. Saville even suggested that: "...if after the initiation of discussions with McDonald...it is impossible to prepare an adequate article on the basis of unclassified discussions, you are authorized to disclose the minimum necessary classified material to provide the essential background."

planning: "tactical planning--the application of forces in being; strategic planning--the allocation of resources to produce forces; programming--the determination of production levels and times; and military worth--the determination of objectives."[72] Paxson and the colloquium participants considered these modes of planning in terms of mathematical models, primarily the Von Neumann-Morgenstern theory of games. For example, Paxson outlined the strategic aspect of the problem:

> First, a military budget is prepared which in size reflects the military estimate of national requirements in regard to security. Second, the total money actually made available must be divided in the best way among operations, procurement of new equipment, and research and development.[73]

All of these activities, particularly research and development, had to be considered as functions of time as well. Using game theory to model these interlocking problems derived from assuming "the present world may be viewed as an alignment of two power groups. Since planning for security depends directly on expected danger, this suggests that a two-person game be set up and that the planning be done simultaneously for the two powers."[74] The attendees met for a month explor-

72. For a summary of the meeting see *U.S. Air Force Project RAND Staff Report*, 1 September 1948, RAND Publication R-103, pp. 45-63.

73. E. Paxson, "Notes on the Theory of Planning in Relation to National Security," 28 June 1948, p. 1, RAND Publication RM-44.

74. Ibid. One of the attractions of game theory to Paxson and other RAND staff was its inescapable connection to social science and economic issues. The probabilities and assumptions on "player" behaviors in a game were inextricably tied to empirical questions about players' assessments of their own and their opponents psychological, social, and economic circumstances. This work at RAND helped stimulate the introduction of game theory and rational choice into economics. Kenneth Arrow would later win the Nobel Prize in economics for research he did on these issues as a RAND consultant in the early 1950s. The most detailed accounts of RAND research, game theory, and the development of postwar economics are Robert J. Leonard, "War as a `Simple Economic Problem': The Rise of an Economics of Defense," in *Economics and National Security: A History of Their Interaction*, C.D. Goodwin, ed. (Durham: Duke University Press, 1991):261-284; as well as Philip Mirowski, "When Games Grow Deadly Serious: The Military Influence on the Evolution of Game Theory," ibid, pp. 227-256.

ing how mathematical modelling might illuminate these basic tasks of military planning. Frank Collbohm, in a conversation with General Orville Anderson, in the Air Staff plans office, captured the sense of energy and dynamic connection to researchers and institutions that pervaded the exercise:

> ...at the present moment we have a working session in this building right now that are [sic] working on it [the problem of planning].... We have people from all over the country, some of the top people in universities, some of the people from OAS [Air Force Operations Analyst Section], some people from OEG [the Navy's Operation Evaluation Group], I don't remember just where they all come from, they're in here for a month or more of actual work, not committee work or conferences, but actually split up into working teams and they are at work now at desk with pencil, paper, and computers at their call, etc., trying to solve these things--set them up and solve them. We are not limited to just the people we hired.[75]

The drawing together of research communities and institutions was one step in creating an active program of research on air warfare. So, too, was the production of reports which would then be distributed across offices in the Air Force, other services and government agencies, industry, and academia. This practice began with RAND's first study on the feasibility of space satellite technology and served to extend and reinforce the various methods of personal contacts described above. Equally important written products helped to codify methods, results, and problems for future research, just as in more established academic fields of inquiry. But with the important difference that nearly all of RAND's reports were classified and available to a limited community of cleared individuals--in and external to the military. Even the summer study on the theory of planning resulted

75. F.R. Collbohm, General Anderson, and others, "Dictaphone Cylinder Transcription re RAND Work," 19 July 1948, p. 9, Folder "FRC Dictaphone Transcripts, 1948," F.R. Collbohm Papers, RAND.

in a series of reports. Marshall Wood, chief of the Planning Research Division for the Air Force Comptroller, who attended the colloquium and served as chair of its Linear Programming Committee, noted "a considerable number of reports were prepared by the several committees and subcommittees, which are available in this office for review by interested personnel. Final reports...are now in preparation, and will include recommendations for the future to be accomplished, either by Project RAND or elsewhere."[76]

Such colloquia, as well as other projects, were also a step in shifting emphasis from the comprehensive ambitions of Williams's military worth program to more manageable (but still large) tasks requiring the combined expertise of various disciplines and professions. In part this reflected the difficulty of implementing Williams's agenda. It also reflected RAND's responsiveness to the service's most immediate problems. While undertakings such as the theory of planning were stimulated by and received the active participation of service leadership, they were less pressing than other concerns. The two crucial problems, integral to service mission in the years before the Korean War, were the intercontinental bombing mission and air defense of the United States mainland. RAND had been working piecemeal on the first almost since its inception in 1946; and in early 1947 was asked to lead an Army Air Forces analysis of the second. Rand's initial treatment of the intercontinental bombing problem focused on well-defined engineering studies, much in the manner of the satellite study of May 1946. Williams's

76. Memo from Marshall Wood, "Report on Field Trip to Attend Conference on Theory of Planning at Project RAND," 11 August 1948, File "Project RAND, Nov. 1947-Dec. 1950," Series 73, RG 341, NARA.

articulation of a broader theoretical and methodological context for RAND's work transformed these studies, broadening their technical scope and including economic perspectives in their analyses. The result was what RAND called systems analysis. The first exemplar would be a study of intercontinental bombing, to be described more fully in the next chapter.

By mid 1948, RAND began to take an organizational shape and focus which would hold for the next several years. A variety of disciplines and professionals defined their research around the idea that the military services constituted a special domain of inquiry. One goal of this collective research enterprise was empirical in the sense of collecting data on the culture and activities of the service, on the state of the world in which it would carry out its mission, and on developments in science and technology. Another, interdependent with the first, was articulating theoretical constructs that would, as in the military worth program, provide the basis for organizing research and drawing conclusions. This definition of RAND marked a departure from the initial thoughts of Collbohm and Raymond. From 1945 through 1946 both sought to connect RAND directly to the research, development, and manufacturing interests of the Douglas Company, particularly in the new fields of guided missiles and atomic propulsion. The expense and difficulties of these new technologies, coupled with declining military budgets and profound organizational changes in the postwar years, thwarted their ability to define the new organization toward this end. Williams's approach, grounded in the wartime experience of operations research and in postwar optimism over the application of science to military matters, provided an alternate organizing template for the young RAND.

The shift was noticeable in Raymond's August 1947 remarks to the Air Staff as part of the RAND-service quarterly briefings: "We are concerned, I would like to emphasize, with systems and ways of doing things, rather than with particular devices, particular instrumentalities, particular weapons, and we are concerned not merely with the physical aspects of these systems but with the human behavior side as well. Questions of psychology, of economics, of the various social sciences, so called, are not omitted because we all feel that they are extremely important in the conduct of warfare."[77] This shift in focus away from the immediate research, development, and manufacturing interests of Douglas coincided with the dissolution of Bowles's expectations for RAND as a managerial link between industry and the service. Other external events were also at work. In fall 1947, as part of a reorganization of the Air Staff in the wake of unification, the LeMay post of Deputy Chief of Staff, Research and Development, the third ranking position in the service hierarchy, was abolished. RAND now reported to the Director for Research and Development, a mid level staff function under the Assistant Chief of Staff for Materiel. With Bowles and LeMay departed, RAND was perceived by many in the service as just another research and development project competing with myriad other such projects. With the burdens of unification, the departure of RAND's two champions, and the retrenchment of service budgets and personnel from 1946 to the Korean War in 1950, the initiative for defining the RAND project shifted from the Air Staff to RAND itself. This combination of events provided

77. Arthur Raymond, "Presentation of Mr. Arthur Raymond on Project RAND," note 37, p. 1.

the opportunity for Williams, Frank Collbohm, and others at RAND to advance a knowledge-based strategy for coordinating social resources as an answer to some of the service's challenges. Collbohm, in particular, came to see systems analysis--the study of the military as a domain of inquiry through the use of mathematics and other modes of disciplinary expertise--as RAND's defining product, the means by which the project could create a unique role for itself.

From Project RAND to the RAND Corporation

This set of events within and external to RAND undermined the reasons for the project's placement at Douglas. The usefulness of the RAND-Douglas connection was further complicated by the service's increasing use of RAND to evaluate important procurement decisions relating to bombers and missiles. Since the 1946 satellite study RAND had played a leading role in defining the service program in the missile field and would continue to do so into the 1950s. Through its analysis of intercontinental bombing the project became involved with selection of a long-range bomber to succeed the B-29 and the B-36. As part of these activities RAND gathered data on the state of the art in missiles and bombers and thus raised a potential conflict with the proprietary interests of companies that might be competing with Douglas for scarce contracts. The Air Force received complaints on this situation, particularly from North American's President Dutch Kindelberger. Donald Douglas, too, saw this as a potential reason for the service to avoid awarding contracts to his company. Indeed, he believed that the failure of the company to win a contract in early 1947 for building C-47 transports, the backbone of the company's military business, was attributable to such sensitivities.

In early September 1947 Arthur Raymond broached the possibility of separation from the Douglas Company with Bowles, who had just weeks earlier left his post in the War Department. Raymond noted that:

> RAND has good momentum now and enjoys fairly healthy prestige in most quarters in Washington. It has, I believe, grown up and the time is fast approaching when it will not need the fatherly support which the Douglas Company has thus far provided. As a matter of fact, it is going to be desirable, both from the standpoint of RAND and the standpoint of Douglas, that a state of almost complete autonomy be established as rapidly as this can practically be done without injury. The endpoint should be one in which the relationship of Douglas men to the working group is exactly the same as that of representatives from other companies.[78]

Raymond and Bowles corresponded several times over the fall but the subject of severing the tie between RAND and Douglas did not come up. Over the same period Frank Collbohm, with the blessing of Donald Douglas, began to explore specifically how this might be accomplished. In November Collbohm arranged to meet with Rowan Gaither, a lawyer in San Francisco whom Collbohm met at MIT Radiation Laboratory during the war. Gaither had served as an assistant director of the laboratory responsible for administration and maintained a continuing interest in the postwar working relationships among the military, industry, and academia. Through his stint at MIT, Gaither developed friendly relations with many of the influential scientists and administrators associated with the Radiation Laboratory--including Lee DuBridge, who in fall 1947 was president of the California Institute of Technology; Karl Compton, president of MIT; and Alfred Loomis, an investment banker and physics enthusiast with close ties to MIT, who had set up his own

78. Letter from A. Raymond to E. Bowles, 10 September 1947, p. 2, Folder "War Effort--Rand Letters, 1944-03/48," Box 1, E.L. Bowles Papers, NASM.

laboratories in Tuxedo Park, New York, before the war to study microwave radar. Because of Gaither's background, Collbohm and others at RAND, in the early part of 1947, had sought his assistance in recruiting academics for the project. To facilitate this work RAND arranged a security clearance for Gaither in May 1947. As a result of the November discussions Collbohm retained Gaither as legal counsel to the project in early December.[79]

Initially, Collbohm and Gaither considered several options for RAND--keeping the project at Douglas, changing its auspices to a university, or converting the effort to an independent nonprofit corporation. After discussions with MIT wartime associates Compton, DuBridge, Loomis, and others, Gaither recommended in early 1948 that the project be established as a nonprofit corporation. The prospect of conducting classified work at a university, although now commonplace at institutions such as MIT and Caltech, seemed to offer more complexities than establishing the project as a nonprofit entity.[80] With Gaither's recommendation and assistance, Collbohm, Arthur Raymond, and Lawrence Henderson (RAND's associate director and head of the Washington, D.C., office) began to plan the separation from Douglas. Given the resistance that RAND had

79. These points are covered in a statement of Collbohm's on RAND's early history recorded in 1954. "Statement by Mr. Frank Collbohm...," 4/12/54, Larry Henderson Papers, RAND, p. 8.

80. Helmer, though, reported to Williams in early 1948 that some members of the Stanford economics department were keen to have RAND come there. Helmer relayed that "they might be able to stir up enough interest for Stanford to take the initiative and to propose financial arrangements to RAND that might be worth considering." Memo from O. Helmer to J. Williams, "Trip to Stanford," 4 January 1948, note 54.

encountered from elements of the Air Force, such as the AMC, and from the influential Vannevar Bush, the group actively sought the advice and support of a number of academics, industrialists, and military officials as they pursued the shift to a nonprofit corporation.[81]

In January 1948 Raymond wrote Bowles of the prospective arrangements. Bowles rightly sensed that the separation of the project from Douglas provided an exclamation point to the unraveling of the original conception of the project. Responding to Raymond, Bowles noted:

> It seemed to me that during the war we set the pattern for cooperation between industry and the military in joint planning. In fact, it was this foundation which made it possible to move along into the peacetime embodiment of defense planning by way of project RAND. Any move toward a reorganization which inherently militates against a strong cooperative relationship--and that means direct responsibility--between industry and military in this undertaking will cause us to lose what seemed to me to be the greatest element in the RAND concept. I have never thought of the Project as a mechanism merely for preserving the interest of scientists.[82]

As Bowles well knew, though, changes in Douglas, the industry, and the Air Forces, as discussed previously, made the reinvigoration of the original idea untenable. Bowles's own departure from the War Department had already made that point obvious. Bowles, nonetheless, asked Raymond plaintively whether the moribund RAND-industry Advisory Council had passed on the change in manage-

81. Lawrence Henderson's recollections offer the most detailed account of plans to establish RAND as a nonprofit corporation, including attempts to cultivate support for the move, connections with the Ford Foundation, and the selection of the first Board of Trustees. See Lawrence Henderson, Oral History Interview, 1989, RAND History Project, NASM.

82. Letter from E. Bowles to A. Raymond, 2 February 1948, Folder "War Effort=Rand Letters, 1944-03/48," Box 1, E.L. Bowles Papers, NASM.

ment. In February the council met with Raymond and Gaither and, as reported by Raymond, "all expressed themselves as being in hearty agreement with the move," ratifying the fact that industry leadership found efforts such as the Finletter Commission (which presented its report to President Truman in January 1948) and congressional lobbying more productive for meeting the needs of aircraft manufacturers.[83]

Raymond, too, wanted to maintain the link between industry and the military. After the war he was active in promoting, in addition to RAND, the interests of industry in a number of forums looking at postwar organization, including congressional committees, the Finletter Commission, and the National Advisory Committee on Aeronautics. But the collaborative managerial structure for achieving the industry-service link envisioned by Bowles would yield to an arrangement more in keeping with Williams's and Weaver's military worth idea: the connection to industry would primarily be through the execution of RAND's research--day-to-

83. Letter from A. Raymond to E. Bowles, 16 March 1948 Folder "War Effort=RAND Letters, 1944-03/48," Box 1, E.L. Bowles Papers, NASM. In a last gasp of frustration Bowles excoriated the RAND effort after reading an annual report: "It is a grandiloquent, bombastic, Hollywood montage, characterized by braggadocio [sic] that bears a resemblance only to the kind of thing that might be given by some careless soul before a Legion convention...such a trite piece of writing would make them [opponents of RAND] wonder in just what way I have been deluded, or should I say tetched, by my war activities." Calming down a little and lamenting his lost opportunity for molding RAND in his vision he continued to Raymond: "I must be careful in what I say to you about this project, because I confess I am emotionally involved. At the same time, I believe there is something bigger at stake than you, or me, or the Douglas Company. Egotistical or not, I have felt that this is one of the biggest and most contstructive opportunities that came out of the war." Letter from E. Bowles to A. Raymond, 5 March 1948, Folder "War Effort=RAND Letters, 1944-03/48," Box 1, E.L. Bowles Papers, NASM.

day working relationships, summer studies, evaluation of industry weapons proposals to the service, and joint participation in the numerous panels of the RDB, the Air Force Science Advisory Group, and other groups. As planning for an independent RAND continued in spring 1948, Raymond, Collbohm, and Gaither were beginning to select a board of trustees for the planned corporation. As a vestige of Bowles's and Arnold's effort to forge a special link between the service and the industry, Raymond sought to have the aircraft industry represented on the board. He and Collbohm invited Oliver Echols, a retired Air Force general and president of the Aircraft Industries Association, the leading trade association for the industry, to participate. Echols apparently declined and, as the RAND Board of Trustees took shape over summer and fall 1948, no individuals representing aircraft manufacturing interests were included.[84]

Collbohm's choice of Gaither to negotiate the transition from Douglas to a nonprofit corporation was fortuitous. Gaither had no vested interest in the Bowles model for RAND and found the military worth concept congenial with his experience at MIT during the war. Gaither's family connections and collegiality with his Radiation Laboratory alumni, though, were more directly relevant to the transition. Before gaining service approval for the new arrangement, RAND had to demonstrate some fiscal ability to implement the Project RAND contract and to compose a Board of Trustees which could inspire the same confidence as the

84. On the invitation to Echols see letter from F. Collbohm to O. Echols, 24 May 1948, Folder "380 Projects, Jan-Oct 1948, Vol. 3," Box 817, Series 1, RG 18, NARA. The fact that a copy of this letter was sent to Air Force officials indicates their interest in the composition of the new RAND board.

Douglas sponsorship. Gaither and Collbohm calculated that RAND would need $1,000,000 to get started; once underway the Air Force contract and RAND's fee from the contract would make the new corporation a going concern. In late March, Gaither arranged for Collbohm to meet with his father, H. Rowan Gaither, Sr., who was founder and president of Pacific National Bank in San Francisco, and with representatives of Wells Fargo Bank. In early May Pacific National and Wells Fargo offered to extend a $600,000 line of credit provided RAND could obtain $250,000 in other working capital or assets. With this expression of support, Collbohm, Raymond, and Gaither proceeded formally to establish RAND as a nonprofit corporation under California law in mid May. Gaither and his law firm in San Francisco handled the filing.[85]

During the discussions with Gaither's west coast banking connections, Collbohm and Gaither had been considering the possibility of foundation support for the new organization. They consulted with Warren Weaver in his capacity as an officer of the Rockefeller Foundation and with Charles Dollard, president of Carnegie Corporation. While noting the reluctance of foundations to grant funds for working capital, they suggested that the Ford Foundation, itself about to undergo major changes in its organization, might entertain a request for support. After Henry Ford's death in April 1947, the foundation received a massive infusion of Ford Company stock and was legally bound to make plans to disburse its

85. RAND's articles of incorporation are in "The RAND Corporation: Organization," 15 May 1948, L. Henderson Papers, RAND.

assets over a period of years.[86] Karl Compton and Donald David, head of the Harvard Business School, were trustees of the Ford Foundation. Through them Gaither and Collbohm approached Henry Ford II and the foundation for support in early June. Through Compton's support and Henry Ford II's apparent interest in the RAND undertaking the request for funds was expedited. After a series of discussions with Compton, Arthur Raymond, Warren Weaver, Collbohm, and Donald David, Gaither and Larry Henderson (head of RAND's Washington, D.C., office and part of Bowles's consultant corps during the war) submitted a formal proposal to Ford on 18 June. With assurances from Air Force leadership that the service would continue the Project, Henry Ford II in late July approved a $100,000 non-interest bearing loan, subordinated to RAND's other loans, as well as a pledge to guarantee the Pacific National and Wells Fargo loans up to $300,000.[87] Ford's only stipulation was that Ford select one of the directors of the RAND board to represent its interests.

The details of how the RAND principals arranged for startup funding only serves to accentuate the broad acceptance of the ideas that underpinned the military worth agenda. The RAND proposal to Henry Ford II noted that the corporation

86. On the history of the Ford Foundation in the late 1940s and early 1950s see Dwight Macdonald, *The Ford Foundation: The Men and the Millions* (New Brunswick, NJ: Transaction Publishers, 1989, originally published 1955).

87. On these developments see Collbohm, "Statement by Mr. Frank Collbohm...," note 79, as well as "Chronology of Organization," 12 April 54 and memo from H. Rowan Gaither to F. Collbohm, 14 November 1958, both in L. Henderson Papers, RAND. The transition to a nonprofit corporation is also covered in Bruce Smith, *The RAND Corporation* (Cambridge, MA: Harvard University Press, 1965); and Fred Kaplan, *Wizards of Armageddon* (New York: Simon & Schuster, 1983).

will "engage in scientific evaluation and analytical studies to aid the National Military Establishment in the formulation of military plans intended to provide maximum security for the nation at minimum cost in manpower and resources. The measure of security achieved through sound military planning may well determine national survival."[88] Perhaps it was the broad sweep of this agenda and the suggestion that analytic rigor could be brought to planning on this scale that stimulated Ford's interest. But while this purpose may have struck a chord with Henry Ford as corporate executive, it is noteworthy that neither Ford nor his foundation could know very much of RAND's work, most of which was security classified. The move to incorporation also signaled an acceptance that the conditions Warren Weaver described in his opening address to the Conference of Social Science, and that Bernard Baruch had already dubbed the "Cold War," were likely to persist and that it was the responsibility of all individuals and institutions to contribute to national preparedness. The new corporate RAND was a concrete symbol that the study of modern war in its broad sweep would also persist.

After the financial arrangements were secure in July, Compton and Loomis again lent their authority and connections to the new corporation by assisting Gaither, Collbohm, and Raymond in constituting a Board of Trustees. By fall 1948 the board was formed and the membership reflected the network of connections that Gaither brought to the project. The board included Gaither as chair, Loomis, Lee DuBridge, Charles Dollard (president, Carnegie Corporation), Philip

88. "Proposal to the Trustees of the Ford Foundation," 1948, L. Henderson Papers, Rand, p. 1.

Morse (professor at MIT and soon to become deputy director of the Joint Chiefs of Staff's Weapons Systems Evaluation Group), Frederick Stephan (professor, Department of Economics and Social Institutions, Princeton University), George Stoddard (president, University of Illinois), and Clyde Williams (director, Battelle Memorial Foundation). With the funding and trustees in place RAND began business as a nonprofit corporation on 1 November 1948.

Separated from the Douglas Aircraft Company and from the efforts of Bowles and Arnold to shape the project as an exemplar of industry-service collaboration, the new RAND would have to secure its own identity. Frank Collbohm, RAND's director, was acutely aware of the need to create an organization, style of work, and products that would serve the Air Force and distinguish RAND from universities, industry, and government boards and offices. The centerpiece of this effort was the concept of military worth and its more practical cousin, systems analysis.

Chapter V

The Strategic Bombing Systems Analysis: From Concept to Practice

Weapons development and modern war called for new mechanisms for connecting the military with sources of science, technology, and expertise in industry and universities. Edward Bowles's failed associationalist strategy had been one attempt to establish such linkages. Those who headed RAND saw the enterprises of military worth and systems analysis as other means to approach this challenge. With the demise of Bowles's effort, the initiative for addressing this problem shifted from service advocates to RAND itself. Air Force leadership was too consumed with the challenges of unification to manage RAND actively. If RAND was to prosper, it would need to define for itself a role the Air Force found worthwhile.

RAND's greatest resource was its growing cadre of disciplinary specialists, numbering almost two hundred by 1948, with mathematicians, physical scientists, and engineers dominating, but also including a small number of philosophers, social scientists, and economists. Frank Collbohm, RAND's director, and John Williams and Edwin Paxson, both mathematicians, were instrumental in directing this resource toward the goals Arnold and Bowles had articulated earlier, but in a way that would draw on RAND's strengths. Bowles had seen research on problems of warfare as one element in integrating the civilian with the military, extrapolating from his close familiarity with the limited application of operations research to military tactical problems in the war. But Bowles envisioned this research activity only in the context of his trade association model. Research would be conveyed to the RAND Advisory Council and service leadership; together they would weigh its value and make decisions. In this way, research could contribute to the goal of coordinating and directing the Air Force's relations with its external markets.

Collbohm, Williams, and Paxson sought to achieve the same end, but without the vehicle of an ad hoc trade association. They would have to define what constituted a military domain of research, what methods would be used for investigating and legitimating knowledge, and how to convey research findings to military and political audiences. Knowledge itself and its presentation would be the vehicles for coordinating the interests of service leadership with other elements of the defense establishment and industry. This chapter looks at how Collbohm, Paxson, and others at RAND pursued these goals through a specific study, the Strategic Bombing Systems Analysis.

RAND first applied systems analysis to a study of the most effective way to deliver atomic weapons with long-range aircraft from the United States to the Soviet Union. The choice of this particular problem arose from RAND's contract mandate to study the "broad problem of intercontinental warfare." As early as summer 1946 Arthur Raymond had composed an outline of areas of research which could be correlated in a "systems study."[1] Of course, the RAND efforts were grounded in the widely-shared view in and out of the service that the long-range bomber and the atomic bomb were, in combination, the crux of the United States's military strength. The ability to successfully complete intercontinental bombing missions was central to the service's identity.

In 1947 Collbohm appointed the energetic and talented Paxson to take over the study. Paxson came to RAND from the Naval Ordnance Test Station (NOTS) where he directed their operations research activities. Before John Williams came to RAND, Paxson had been Williams's boss at NOTS. And like Williams, Paxson viewed enthusiastically the possibility of applying mathematics to military problems of broad scope. Paxson reorganized the study, drawing in economic concepts of cost, and began presenting findings to the Air Force in September 1947. But data collection and analysis would continue until early 1950, when Paxson would prepare a draft report and he and Collbohm would begin a series of briefings to the Air Staff, industry, and others.[2]

But the study's importance for RAND was amplified by two developments which invested the analysis with practical significance. One was an intensive review by the Air Force, begun in late summer 1947 and continuing through 1950,

1. See J.R Goldstein and A.E. Raymond, "RAND Work Outline," July 1946, RAND Publication RAD-1.

2. *Strategic Bombing Systems Analysis*, 1950, RAND Publication R-173.

to choose a long-range bomber to succeed the B-29, the workhorse of the war in the Pacific, and the B-36, a massive, but trouble-plagued bomber just coming into use. The leading candidate was the B-52, but Boeing, which held the research and development contract, encountered serious problems in settling on a design that satisfied Air Force requirements.

The other development was a review started in late 1949 through Secretary of Defense James Forrestal, the Joint Chiefs of Staff, and the Weapons System Evaluation Group on how to conduct an atomic air offensive against the Soviet Union. The RAND study would become part of the intellectual and political process of addressing both these questions, and in so doing would secure systems analysis as RAND's signature product.

Early Phases of the Bombing Systems Analysis

Soon after its initiation in March 1946, RAND began to research component elements of undertaking a long-range air attack against the Soviet Union. One project, called the Interim Study, was "to evaluate the possibilities and limitations of current or nearly developed weapons." The weapons of interest were aircraft with reciprocating engines--bombers typical of World War II, such as the B-29, and two others in the development stage: the B-50, a modification of the B-29 design, and the B-36. The goal was to analyze these designs and assess the interrelations among the variables of weight, payload, aerodynamic qualities, and engine characteristics to determine their affects on range. The result was a general equation for these type of aircraft, suggesting the limits of performance of current aircraft as well as providing insight into possible designs that might better serve the needs of long-range attack.[3]

In fall 1946, through Bowles's prodding, RAND subcontracted other aspects of the question of long-range attack to Boeing, Northrop, and North American. Boeing assisted with the Interim Study; Northrop examined the possibilities of the "flying wing" (a tailless aircraft design of keen interest to company founder Jack Northrop), and North American looked at the question of how enemy fighter defenses, in engaging attacking bombers and their fighter escorts, might affect the success of the bombing mission. RAND staff and their subcontractors also started studies on aerial refueling and the optimum number and locations of air bases intermediate between the United States and the Soviet Union. These latter studies stemmed from the fact that the B-29 and B-50 had ranges of approximately 2,000 miles, insufficient for a round-trip attack. The B-36 had a range of 8,000 miles but, depending on route and flying conditions, might also need refueling or access to an intermediate base. Studies were also started on evaluating targets (e.g., transportation and industrial assets) as well as on optimum patterns of bombing to ensure target destruction.

By early 1947 RAND researchers formally recognized the connections among these studies by renaming this area of research the Aerial Bombing Systems Analysis. To this point, each of the studies was rooted in an assessment of existing

3. On the Interim Study see *Project RAND Second Quarterly Report*, 1 September 1946, RAND Publication RA-15004, pp. 14-27.

or developing technologies. The analyses, in their scope and definition, resembled operations research studies of the war. Under the direction of L.E. Root, head of the Airborne Vehicles Section, the research effort was now broadened slightly to assess collectively nine different modes of executing a bombing mission, assuming a 5,000 mile range and a 10,000 pound bomb load (see Figure 12). The range and payload criteria reflected the assumption that the bombing mission was an attack on the Soviet Union with atomic bombs similar to the one used on Nagasaki in August 1945. The modes of attack included one-way bombing missions (to compensate for the limited range of available aircraft), nuclear-powered bombers, guided missiles, and airplane-missile combinations. It is noteworthy that most of these systems were not developed or even likely to be developed in the near future. These various systems would be compared through what Root and his colleagues dubbed "efficiency-time curves." This measure sought to determine the overall effectiveness of a given weapons system--primarily in terms of "proportions of bombs dispatched which hit the target." This measure included such factors as reliability of the system, tactics, and proficiency in aiming, as well as enemy ability to destroy attacking aircraft or missiles. Here the criterion of time entered as well. Over time, enemy defenses presumably would have improved success in resisting attacks, and the level of such success would be determined, in part, by the vulnerability of the attacking aircraft or missile. Another measure of efficiency--the cost of a weapons systems in relation to its destructive ability--was also contemplated.[4]

4. On these points see *Project RAND Fourth Quarterly Report*, 1 March 1947, RAND Publication RA-15033, pp. 9-14.

Figure 12: "A Method of Appraising the Capabilities of Aerial Bombing Systems," 1947

Source: RAND Publication RA-15033.

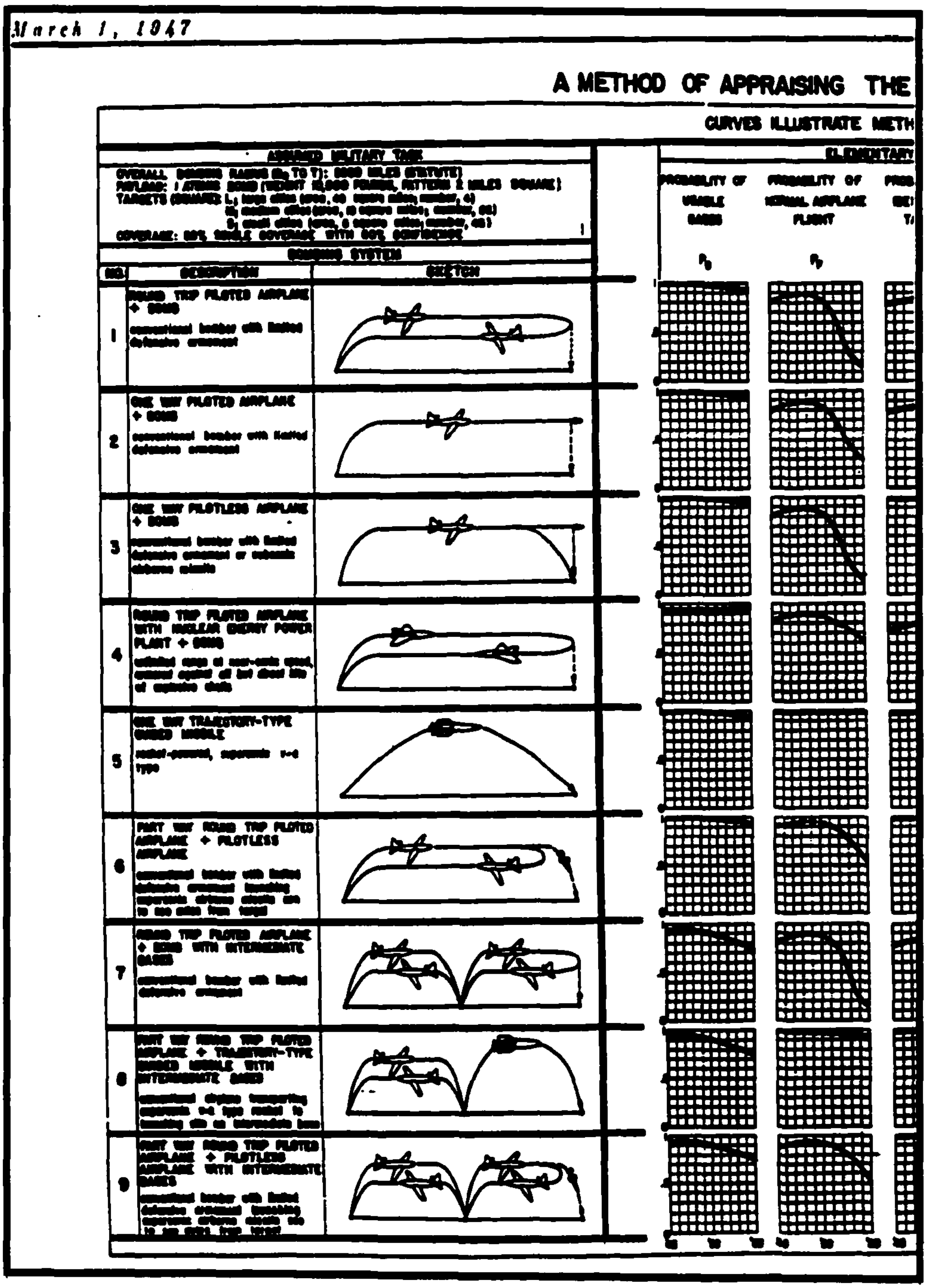
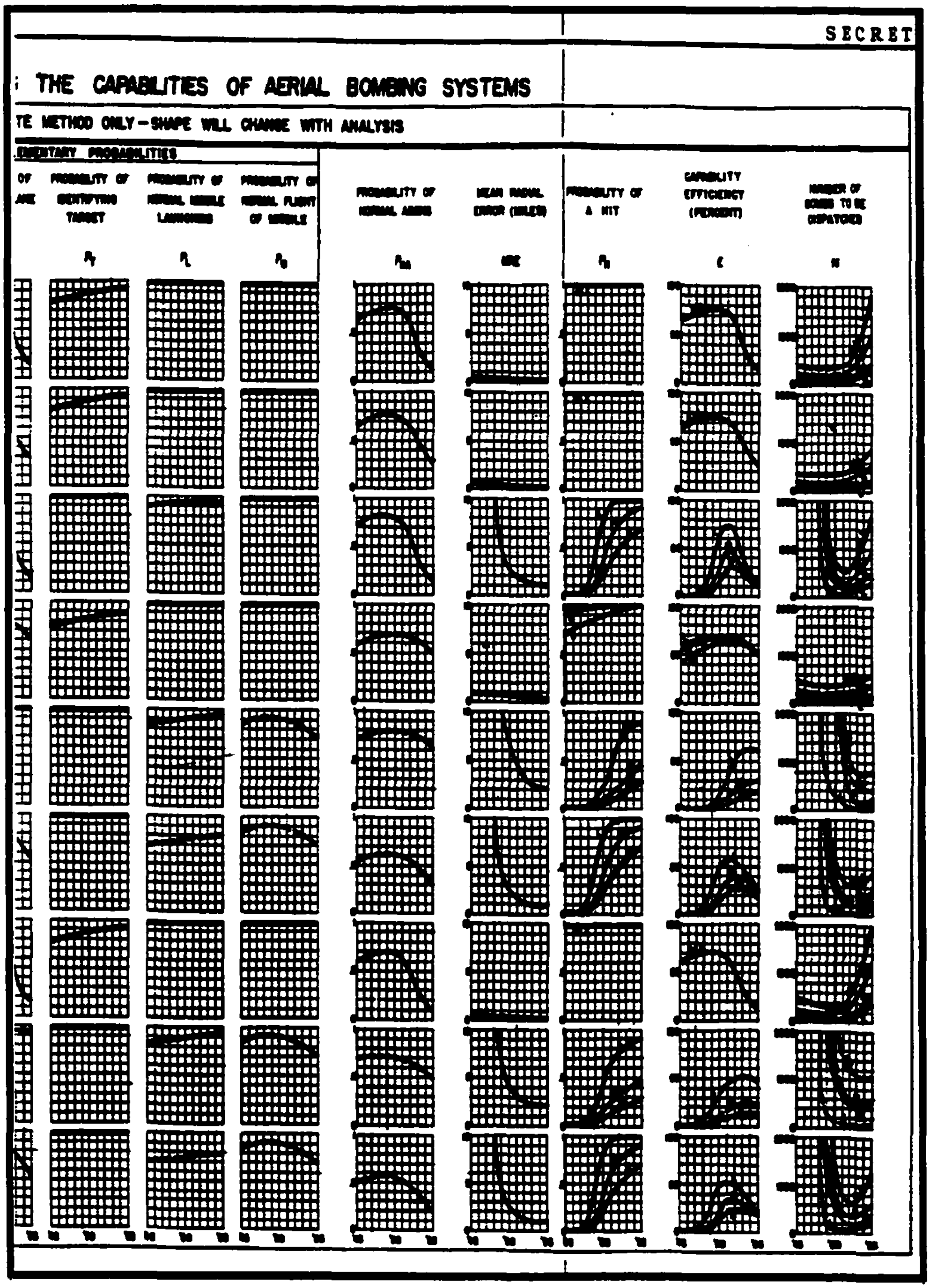


Figure 12 (cont.)



By summer 1947, as John Williams was preparing for the Conference of Social Scientists, researchers redefined the study in several important ways. One was to strengthen the research approach. As noted in a progress report, "RAND is now working intensively (1) to establish more precise analytical methods for the systems analysis, (2) to introduce economics and logistics into the study, and (3) to collect more accurate data to refine the estimates of the chart [Figure 12, cited above]." The inclusion of economics, logistics, and more comprehensive data collection were an outgrowth of Williams's work on military worth. So too was the call for "more precise analytical methods."

One step in improving methods was to develop probability models for key aspects of the study, such as the attrition to be expected from enemy fighter attacks on invading forces and the likely damage resulting from particular patterns of bombing targets. In each case, RAND researchers set up experimental devices to develop these probabilities. For the fighter question, Paxson developed "a three-dimensional plotting room" in which mock engagements could be analyzed. On target coverage, Williams tried to build a mechanical device using ball bearings to simulate bombing runs and assess the probability, under varying conditions, of destroying a target with a given number of bombs. Employing more precise methods also meant utilizing the mathematics section's growing expertise in game theory, which was useful for enumerating the matrix of possiblities that might arise in evaluating a conflict (such as between a defending fighter and attacking bomber) and assigning probability values to those variables.[5]

5. See *Project RAND Fifth Quarterly Report*, 1 June 1947, RAND Publication RA-15036, pp. 11-15.

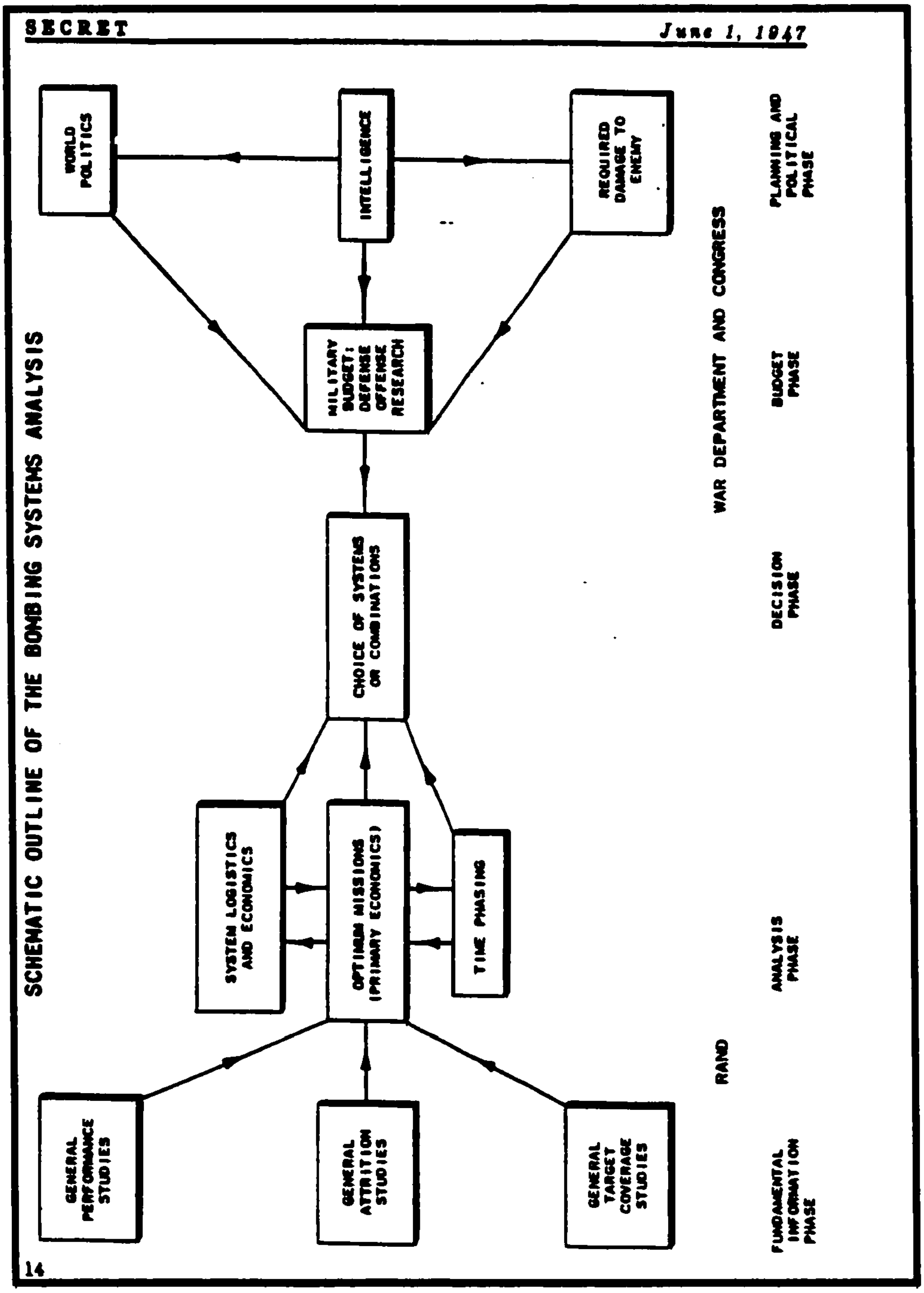
The other important change in the study was to restrict the number of possible systems analyzed. Rather than consider systems unlikely to be developed for many years, the study would focus on "the best performance to be expected from manned bombers flying at subsonic speeds." With this change, the Aerial Bombing Systems Analysis now concentrated its effort on a question of immediate relevance to the Army Air Forces--the state-of-the-art weapons with which the service would have to fight a war in the next few years. There were now six modes of attack to analyze: one-way from home bases, one-way with refueling, one-way utilizing intermediate bases, and the same set of options for round-trip missions.[6]

These changes provided the basic analytic framework for the study as it was elaborated from late 1947 through early 1950. The reconceptualization of the study reflected the impact of Williams's thinking on military worth. This can be seen in a schematic (Figure 13) prepared to describe the study in summer 1947. Inputs on the left side of the diagram represented technologies, operations, costs, and development over time for given weapons systems. Inputs on the right represented international events, domestic politics, congressional appropriations, and national and military policy. These sets of inputs then converged on a preferred weapons system (or systems), dependent on the values of these inputs. As in Williams's articulation of military worth, appropriate mathematical and computational methods would be needed to achieve this end. As the report containing the schematic noted: "The interdependence of the various parts of the analysis indi-

6. Ibid.

Figure 13: "Schematic Outline of the Bombing Systems Analysis," 1947

Source: RAND Publication RA-15036.



cates the probable need of massive calculation following a complete formulation of the Systems Analysis. High speed electronic computing equipment appears to be essential."[7] The whole range of variables suggested by the schematic constituted an area of connected phenomena, amenable, in theory, to investigation. The implication of the RAND schematic was that the Bombing Systems Analysis might correlate arcane technical details, institutional objectives, and national policy and in the process define the relations among each.

The final significant element in redefining the study was to formulate the basic problem to be solved. Despite a series of crises and events in foreign affairs--confrontations over Iran and Turkey in 1946, tension over Greece in 1947, leading to the enunciation of the Truman Doctrine and the start of the Marshall Plan--President Truman continued to restrain military spending. This funding policy seemed likely to continue for the foreseeable future. In this context, RAND researchers decided that two of the crucial variables for their study were "the Money S available for a force and the strength of the enemy reaction." The problem to be solved was "to determine what airborne bombing system (or combination of systems) will cause the most damage to the enemy for any given value of the sum S and given strength of enemy countermeasures." Implicit in the RAND approach was that money was a limiting factor in choosing a weapons system as well as a shorthand expression for a range of political and policy choices connected to assessments of the Soviet threat.

7. Ibid, p. 13.

To this point, Root and other RAND staff had communicated progress on the study and its components through quarterly briefings to the Air Staff. These briefings were one means, in addition to written reports and day-to-day working relationships, that RAND and the Air Staff exchanged information. RAND would report on its research; military officers would provide summaries of current actions or thinking on war planning, intelligence estimates of Soviet capabilities, the state of various procurement programs, or other subjects.[8] RAND maintained a Washington, D.C., office, headed by Larry Henderson (who also was a member of Bowles's consultant corps during the war). Henderson helped arrange the meetings, but more importantly served as a trouble-shooter and a conduit to keep RAND management and researchers apprised of Air Staff developments on a daily basis. Soon after going into business in 1946 RAND also established a small office in Dayton, Ohio, the site of Wright Air Force Base and Headquarters of the Air Material Command (AMC), the service organization responsible for research and development. Typically, after briefing the Air Staff, RAND researchers traveled to Dayton to repeat their presentation and to get more detailed insight into the AMC's laboratory programs and contracts with industry.

8. The memoranda on these briefings are in AF Headquarters files on RAND for the period. See for example memo from Curtis LeMay, DCS, Research and Development to Assistant Chiefs of Air Staff, 9 April, 1947, Folder "380 projects, 1946-47, Vol. 3," Box 639, Series 1, RG 18, NARA. The cover for this memo notes: "As a means of assisting RAND personnel...with AAF contract for studies...for the conduct of intercontinental warfare other than surface the quarterly briefings have been a success. These briefings, heretofore, have been confined to formal presentations by both AAF and RAND personnel. For the next quarterly briefing...these formal presentations will be followed by conferences wherein RAND members will be permitted to discuss various phases of AAF plans and programs."

Operations Research and Systems Analysis

Before looking further at the development of the bombing systems analysis, it will be useful to compare the study with operations research practice in World War II. A well-known and typical application of operations research was the attempt to thwart German submarine attacks on Allied transport convoys at the beginning of the war.[9] As a research problem, it was a straightforward exercise in applied physics and mathematics. The challenge was in identifying the variables that needed to be analyzed: the characteristics of German U-boats, their speed, range, and tactics; the physical attributes and performance of torpedoes; and on the Allied side precise information was needed on capabilities of destroyers, various types of radars and sonars, underwater decoys, aircraft, and the efficacy of various search strategies. Where data did not exist on these variables, the operations research groups (primarily the Navy's) could gather it by going into the field in the fashion of a laboratory experiment. The war presented the problem for research and the opportunity to collect data for an analysis. The real challenge in confronting the submarine menace was not the technical complexity of the problem but the novelty of incorporating scientists and mathematicians into military commands and inter-service rivalry between the Navy and Army Air Forces. The organizational politics were not resolved until 1943. One of Bowles's first tasks when he joined

9. The best description of this example is Keith R. Tidman, *The Operations Evaluation Group: A History of Naval Operations Analysis* (Annapolis: Naval Institute Press, 1984), chapter 1. The policy and institutional angles of this wartime episode, including Bowles's role in addressing some of the organizational issues, are covered in Elting E. Morison, *Turmoil and Tradition: A Study of the Life and Times of Henry L. Stimson* (Boston: Houghton Mifflin Co., 1960):563-580.

Stimson in the War Department in 1942 was to enter in this fray and help provide a solution.

Operations research typically grappled with problems, like the anti-submarine warfare, that were bounded in a physical, mathematical, and tactical sense. The variables could be defined and assigned realistic values based on previous experience or by data gathering. Problems, thus, could be formulated precisely and solved for reasonably clear answers, such as the best tactics for avoiding or repulsing submarine attacks.

The early phases of the bombing systems analysis resembled the approach of wartime operations research. To the degree the analysis was defined in terms of exploring existing technologies and a very idealized conception of how an aircraft would execute an attack, the number of variables was limited and their possible values could be readily determined (refer back to Figure 12). In some cases, such as the target coverage device and Paxson's "three-dimensional plotting room," ingenuity might provide an experimental basis for gathering data and assigning values to probabilities of target coverage during bombing runs or of attrition in air-to-air combat. But the problems that motivated systems analysis did not lend themselves to operations research-style precision. As seen in the thinking of Williams and Weaver in the last chapter, the challenge for analysis was to describe future states of affairs, in which extrapolations from the present could be made with more or less confidence. Such a consideration prompted Gene Root to drop technologies, such as nuclear-powered airplanes, from the bombing study whose performance was largely a matter of speculation.

This complication was only amplified by the view that modern war necessitated a wider frame of analysis, leading to more variables, more difficult to connect with reliable data (refer back to Figure 13). It was this concern with future states of affairs and the wider scope of analysis that distinguished systems analysis from wartime operations research in the eyes of RAND researchers. RAND's facility in adapting little-used or new mathematical techniques, particularly game theory, seemed to make the prospects for such expanded scope of analysis quite plausible. Game theory, for example, seemed to offer the possibility of modeling questions of individual, group, or national intent, and their relation to political choice or conflict. One of the first steps in modeling a problem using game theory was to assign probabilities to various courses of action for each combatant. For a case such as Paxson's bombing analysis some of these probabilities represented numerical shorthands for those inputs on the right side of Figure 13--the state of world politics, knowledge of the enemy, the size of the military budget and its allocation among offense, defense, and research, and other factors. The messy worlds of psychology or politics, thus, might be reducible to mathematical treatment. The promise of game theory in addressing such challenges motivated Paxson to organize the conference on the "Theory of Planning" described in the last chapter. This verve and ambition in exploring new mathematical approaches to the study of air warfare also separated systems analysis from the wartime practices of operations researchers. It was a measure of the confidence of Paxson, Williams, Von Neumann, and others at RAND and the wide-spread faith in scientific method that such an enterprise seemed possible and offered the promise of helping to organize for modern war. This presumption would soon be tested as Paxson presented his preliminary work on the bombing systems analysis to the Air Force.

The Aircraft and Weapons Board, the RAND Systems Analysis, and the B-52

In August and September 1947, the bombing systems analysis entered into another crucial forum concerned with service decision making. Earlier in the year, the legislative battles over unification had largely been resolved and the service began to plan to revamp its organization for the new National Military Establishment. In summer 1947, Chief of Air Staff General Spaatz settled on a reorganization that emphasized "men and materiel" and eliminated Curtis LeMay's position as Deputy Chief of Staff, Research and Development. To compensate in part for this loss, LeMay suggested to Spaatz that the Air Staff establish an Aircraft and Weapons Board (AWB). Spaatz agreed and established the board in August 1947, with the charge to assess research and development programs for major procurements, either underway or soon to be considered. Members of the Air Staff and the heads of major commands, such as the Strategic Air Command (SAC) and the AMC, comprised the board.[10]

The creation of the AWB maintained a place for consideration of research and development issues at the top of the Air Staff. But it also brought these issues closer to interest group politics. In addition to coordinating weapons with missions

10. On some of the service organizational changes in this period and on the establishment of the AWB see Robert Futrell, *Ideas, Concepts, Doctrine: A History of Basic Thinking in the United States Air Force, 1907-1964* (Maxwell AFB: Air University, 1971):107-108.

and establishing performance requirements for new weapons and those under development, the board also was charged with selecting "specific aircraft and weapons models for procurement."[11] This had never been in LeMay's purview. With this important charge as part of their responsibility, the board carefully reported its deliberations to Secretary Stuart Symington. As civilian head of the Air Force, Symington led the effort to persuade Congress and President Truman of the service's needs. He was one of the most committed advocates for a well-equipped air force, continually pressing the case for larger appropriations and greater procurement authority. As RAND's systems analysis was presented to the board over the next few years, the politics of procurement were never far in the background.

The AWB first met in August 1947. One crucial item on the agenda was a review of the medium and heavy bomber projects, particularly the B-52. Just before the end of the war Boeing had won the contract for developing a long-range heavy bomber--one to succeed the B-29, the largest bomber of World War II, the B-50 (essentially a modified B-29), and the B-36. The goal was to produce a plane that could carry a heavier bomb load and travel longer distances at higher speed. The initial contract called for a bomber with a combat range of 6,000 miles, a cruising speed of 410 miles-per-hour, and a gross weight of 360,000 lbs. By December 1946, with war planning by the Joint Chiefs of Staff well underway, the

11. On the functions of the AWB see memo from CG, AAF to S. Symington, Subject: USAF Aircraft and Weapons Board, 27 August 1947, Folder "334 Boards and Committees (Alpha Order), 1947 Decimal Files," series "former" 40, RG 107, NARA.

service changed the performance specifications.[12] The Army Air Forces now wanted a plane with a 12,000-mile range, 400 miles per hour cruising speed, and a gross weight of 480,000 lbs.[13] The shift in military expectations for the B-52 played havoc with Boeing's design work, and the plane ran into trouble. To achieve the range and payload requested by the service Boeing engineers proposed an even heavier aircraft. In design, more weight meant more cost and less performance. Such a trend in the Boeing design raised prospective difficulties in selling such a plane to Congress and the President.

In spring 1947 LeMay asked RAND to evaluate the Boeing design, and their conclusions were "somewhat alarming," noted an Air Staff officer, referring to the increasing weight of the proposed Boeing plane.[14] Assessments by RAND and the AMC--the research, development, and procurement arm of the Air Force whose role in these matters Bowles had hoped to curtail--suggested that the Boeing plane promised to be far too heavy, weighing from "500,000 lbs to infinity."[15] The interrelation of design parameters were such that small increases in payload capacity resulted in "a tremendous increase in the aircraft's gross weight." And, a

12. On war planning in this period see Eduard Mark, "The War Scare of 1946 and Its Consequences," *Diplomatic History* 21 (1997):181-415.

13. On the early history of the B-52 project see Memorandum H.A. Craig, DCS/M, to Director R&D, DCS/M, 15 January 1948, Folder "Appendix to Vol. 1, XB-52 Airplane, Series 22, RG 18, NARA.

14. Memorandum A.R. Crawford to AC/AS-3, 23 April 47, Folder "Appendix to Vol. 1, XB-52 Airplane," series 22, RG 18, NARA.

15. Quote in a later summary of B-52 decisions. Memo from Maj. Gen. Partridge to Directorate, Research and Development, 15 June 1948, Folder "Appendix to Vol. 1, XB-52 Airplane," Series 22, RG 18, NARA.

RAND analysis for the Air Force noted, "should the Boeing Company fail to meet their weight estimates by as little as 2%, the B-52 will miss its currently estimated performance (particularly in range) by a great amount."[16]

The stakes in this evaluation were high. The time between initiation of research and development and delivery of production articles was estimated to be 6 to 8 years. The optimistic assumption was that B-52 production models would enter service in 1952-1953, when B-29s and B-50s would be only marginally effective. And the ability of the trouble-plagued B-36 to fulfill war plan objectives was uncertain. If the Boeing plane turned out to be unable to perform as needed, the strategic mission would be ineffectual at best against expected improvements in Soviet defensive and offensive forces.

RAND's policy was to avoid participation in Air Force-contractor procurement relations. But part of RAND's data collection and analysis function was to assess the capabilities of current technologies. The project could not withhold such expertise when the Air Force requested assistance. The service did so in this case and RAND agreed to help. RAND and Boeing had already been collaborating on identifying general formulae for evaluating airplane designs as part of the early phases of the bombing systems analysis. Members of the AWB, apparently on the basis of the quarterly briefings and RAND reports, had developed some confidence in the possible results of the RAND study. At the August meeting they decided to

16. See memo from E. Powers to L.C. Craigie, 25 April 1947, Folder "B-52, October 1945-September 1948," Series 170, RG 341, NARA, and other documents in the same folder.

"continue the B-52 development program, contingent on results of a RAND study to determine the optimum method of delivery of the 'A' bomb."[17]

The AWB met again in September, asking RAND to present its work to date on the bombing systems analysis to a subcommittee tasked to examine the "heavy bombers." By then, Collbohm and Williams had placed Ed Paxson in charge of the study, and both he and L.E. Root briefed the subcommittee. Paxson provided an extended discussion of the analysis articulated a few months earlier. He noted that in its first phase the study, in considering the problem of delivering the atomic bomb to the Soviet Union, looked at technologies that would be available in the next five years--subsonic bombers with reciprocating engines. The assumptions of Paxson's study and the interests of the AWB were identical. As Paxson would make clear in his talk both shared a concern for readying an atomic-capable air offensive at the earliest time--or in the words of Arnold and other air advocates--an air force-in-being, available immediately at the outbreak of any war.[18]

Paxson spent only a small portion of his time on the political variables (refer back to Figure 13) that were ostensibly part of the study. He discussed in passing that appropriations provided by Congress would "depend on the world political situation" and that this in turn would depend, in part, on the ability of the United States to gather intelligence on the Soviets. Without irony, Paxson, whose own

17. Memo from CG, AAF to S. Symington, 27 August 1947, note 11.

18. For a transcript of Paxson's presentation see "Aerial Bombing Systems Theory and Analysis," unfoldered, Box 17, Brownlee Haydon Papers, RAND.

briefing was classified "secret," offered that in the Soviet Union "what is called a state "secret" is defined so broadly that it curls your hair."[19] Paxson worried that such secrecy made intelligence gathering difficult, complicating the job of planners, such as his audience, to "sell the urgency of this situation to the people that supply the money."[20] But for the purposes of the study this political uncertainty meant that analyzing the behavior of Congress was fruitless. Paxson decided to treat funding as a parameter with several possible values and determine what damage could be accomplished with the class of weapons under consideration given particular budgets.

Paxson focused most of his presentation on an examination of technologies and their use. The question of technologies relevant to the study encompassed three areas: "aircraft capabilities and limitations," the "concept of attrition" (the interaction of invading forces with Soviet air defenses), and "target coverage" (selection of targets and assessment of different procedures for distributing bombs on targets). Each of these areas, although overlapping, had hundreds of component elements (especially for the first two), each of which could vary over some range of value. The point of the exercise was to determine the best system (or systems), in terms of cost and damage delivered. These component elements, each with its own range of values, had to be correlated and assessed against each of the others. For example, for Soviet air defense the kind and number of fighter aircraft deployed to intercept incoming bombers and fighter escorts could have a range of

19. Ibid, p 5.

20. Ibid, p. 6.

values. These interceptors also might use different kinds of armament such as machine guns of different caliber, rockets, "toss bombs," and even "rocket firing turrets." The speed and design of the fighters might vary. The strength, placement, and reliability of Soviet radars used to guide the fighter forces also had to be factored in. Assumptions about each of these would correspondingly affect calculations on the number of bombers that could successfully reach target and deliver their bombs. The number of details Paxson included was striking. In considering the issue of intermediate bases for launching attacks, Paxson noted that while Iceland had plenty of open space suitable for runways it was too "hard to get gasoline there," either on boats or via air transport.

Paxson planned to do calculations and comparisons for the six different mission profiles listed above, yielding, ideally, an answer to the question of what was the best system. The central feature of such a system would be an airplane, perhaps one that was not even in development or design. Based on the wealth of detail in the study and RAND's work on general formulae for evaluating aircraft performance, the study would yield, according to Paxson, an "analytic airplane." The analysis could specify a preferred plane at a level of detail somewhere between the Air Force's basic performance standards and a full-fledged design--enough information so that it could be compared to existing, in-development, or proposed aircraft. In identifying the best system, Paxson saw his job as "to try to get the specifications for airplanes in complete harmony with the attrition situation, with the bomb coverage situation and with the money you are allowed to do the job." Paxson noted that RAND was building up its computing capability to handle the massive quantity of data and to perform the thousands of calculations that were at the heart of this comparative exercise.

This challenge alone was breathtaking. But Paxson noted that this part of the endeavor implied a "nice static engineering problem." "The stinker in all this," he noted, "is the time-phasing problem."[21] Even if such an analysis identified a best system, how would you plan the research and development, production, operational deployment, and training? And would the system after the interval from decision to operational readiness still be the "best" or even be available should war break out? The technical question of the best system was still inextricable from a larger context: the politics of the allocation of resources and the probability of war. Paxson noted that RAND had a mathematical tool--game theory--that might help with that problem, too. Game theory, Paxson stated, could, for given probabilities of war, suggest the best way to allocate resources to produce a given weapons systems at a time when it would most likely be needed.[22]

Paxson's talk focused on his research design, the complexities of the study, and the wide applicability of analytic methods. He would take more than two years to acquire all the data and perform the calculations to determine a "best system." But the September talk did demonstrate some of the conceptual and prac-

21. Ibid, p. 4.

22. As a related endeavor Paxson was exploring the application of game theory to a theory of national planning for resource allocation. He would organize a summer study on the subject in July 1948. This conference is described in the previous chapter.

tical ways in which RAND's effort to make the varied aspects of the Air Force a domain of research was taking shape. One conceptual aspect was a shared enthusiasm for the possibilities for modeling the technical and political elements integral to the service. As Paxson went through his talk and answered questions, not one military officer expressed doubt as to the feasibility of the exercise. One officer even wondered whether mathematics might demonstrate that the United States' long-standing policy of not striking the first blow in a war was outdated:

> Have you, mathematically, approached this angle from the stand point that we may have to go and sell the American public on the point that if we are to survive we may have to change our tactics and strike the blow first rather than wait for the blow to be struck at us and then not be able to carry any second blow to him....The first blow may be so great that we would not survive and if we choose to survive we might have to strike the first blow....The mathematics of this may come out so black that we then have to say "Ok, this nation must strike the first blow to survive."[23]

The condition of a first strike was not part of Paxson's model. He noted that it could be introduced as a variable, "but it is going to [take] a terrific amount of psychological and political preparation to prepare the country for acceptance of the assumption." Collbohm, who was also at the talk, described RAND's effort to build its expertise in the social sciences and offered that preparing the public for this possibility should be researched. A shared presumption at the meeting was that thorny political or ethical issues might be amenable to mathematical treatment and, in so doing, be de-politicized.

But there was a point of tension buried in this optimism over mathematical modeling and expertise. The study's conclusions, instead of reinforcing Air Force

23. Ibid, p. 37.

assumptions, might run counter to service expectations and interests. Paxson pointed out, as one of his preliminary insights, that given fixed budgets and an emphasis on economy, that the best weapons system might be a bomber close to the then state of the art rather than one which had substantially improved range, speed, or operating altitudes. There were two reasons this might be the case.

One was that research, development, and production costs for an improved bomber would be dramatically higher than for a bomber of lesser capability. Since the 1930s there had been a clear, upward swing in the unit cost of bombers as they became larger and incorporated more advanced technologies. Under the assumptions of the study, Paxson noted, the Air Force could buy more of the less sophisticated plane. And the difference in the number of planes purchased would be amplified by a basic rule of production. A larger purchase order would allow industry to realize efficiencies in production and drive down further the cost of an individual aircraft. Such considerations, Paxson argued, might tip the balance in favor of the less able aircraft. Because the object was to maximize the destruction of enemy targets within a fixed budget, a larger number of adequate bombers might fulfill the mission better than a small number of high performance aircraft. The second reason, harking back to Paxson's concerns over time phasing, was that the less capable bomber could be produced sooner, creating an Air Force capable of attack on the Soviet Union at an earlier date.

Such a conclusion was antithetical to Air Force thinking and to the motivations that had led to the establishment of RAND. Both the service and RAND believed as an article of faith that World War II had marked the beginning of a relentless dynamic of advance and obsolescence of war technologies. As a matter of survival new technologies had to succeed the old. This, combined with the risk of global war, motivated efforts to connect the military with private sources of science and technology. Technological advance and a concern for military readiness, Paxson suggested, might be objectives that conflict rather than reinforce each other. Paxson's tentative observation on the benefits of a merely adequate aircraft was greeted by the military officers in his audience with silent skepticism. Paxson tried to reassure them:

> I would like to repeat why I am doing this. If you have a given sum of money available it may be better to get a lot of airplanes of given type and actually defer building a new one even though you could build an improved model. Because from the point of view of an air force-in-being it might be better to have a large number of airplanes, larger losses but a total greater number getting through to do the job. It is a funny proposition. You can argue progress certainly means doing the best you can at every instant but you may not be able to have enough volume of the best at each instant under a plan like that and this is one of the big binds in the problem of time phasing.[24]

With the bombing analysis in its early stages, Paxson's observation generated no disputes. In part, this may have been attributable to the uncertainty over when a crucial new technology--jet engines--would be available to replace reciprocating engines on bombers. The availability of the jet engine would be the critical factor in developing an improved bomber. In 1947 such engines, which offered improved speed, were just coming into use on a few aircraft.[25] As part of its aircraft studies, RAND had subcontracted with Westinghouse to assess developments

24. Ibid, pp. 25-26.

25. For example, the service planned to use jet engines in the B-47 medium range bomber which would enter production in 1949 and was built by Boeing.

in the field. Given the promise of jet engine technology, Paxson's conclusion seemed a remote possibility to the military officers in his audience. Paxson, though, would still be arguing for the validity of his observation on the trade-offs between available and new technology when the study was completed two years later--and when the near-term production of reliable jet engines seemed assured. And at that point, Paxson' study would reveal the tension between his analysis and the service's commitment to technological advance.

While Paxson's talk to the AWB illuminated some of the conceptual threads running through RAND's project to research air warfare, it also had practical consequences. RAND's direct evaluation of Boeing's XB-52 in spring 1947 pointed to specific problems in design.[26] Paxson's September presentation opened up the difficult question of the very type of bomber to be pursued and the performance standards it should possess. During fall of 1947, Air Staff planners grew increasingly pessimistic about Boeing's work on the XB-52. Paxson's presentation would be the basis for revising performance standards for the troubled bomber. In fall 1947, with the uncertainties surrounding unification discussed before, this successful contribution to Air Staff planning was a real boost to RAND's self image. In October Arthur Raymond noted that:

> This morning we saw Colonel Perkins who was Chairman of the Subcommittee on Heavy Bombers that visited RAND three weeks ago. They have come out with a proposed requirement for a heavy bomber which they want us to check as to practicability and approximate gross weight before they start it through the mill. It was very gratifying to see the influence of RAND's work and information given concrete form in these

26. The designation XB-52, in Air Force terminology, referred to the first test articles of an aircraft. After production the designation was B-52.

> requirements. In my mind it begins to justify the faith we have been placing in the Project. Another year of work will, I am sure, convince even the most skeptical. Whatever happens we must see that it is not stopped just as it begins to bear fruit.[27]

In November, the AWB decided that, instead of a bomber with a 12,000-mile range, 400-mph speed, and 480,000-pound weight a smaller, faster plane was required--8,000-mile range, 500-mph speed, and 300,000-pound weight. As the Boeing-Air Force frustrations on the XB-52 had shown, it had been extremely difficult to design a plane to the original standards--the weight could easily balloon out of control. The initial range requirement reflected an ideal for strategic bombers: round trip attacks from the United States to the USSR. The less demanding 8,000-mile range was barely adequate for round-trip attacks. It was a concession that for the near future strategic bombing campaigns might still have to rely on intermediate bases and the new practice of midair refueling.[28] Indeed, as part of the background work for bombing systems analysis RAND conducted a study which championed this approach and which became a standard tool for increasing the range of aircraft. Because the revised performance standards were substantially different from the original requirements, the AWB wanted to cancel the Boeing contract and solicit industry proposals to design and produce the new bomber. As part of this process both RAND and the AMC were assessing the Boeing work and recommending the new design parameters.[29]

27. Letter from A. Raymond to E. Bowles, 23 October 1947, Folder "War Effort--RAND Letters, 1944-03/48," pp. 2-3, Box 1, E.L. Bowles Papers, NASM.

28. On this point see, for example, memo from L.O. Peterson to Gen. Partridge, 14 June 1948, Folder "Appendix to Vol. 1, XB-52 Airplane," Series 22, RG 18, NARA.

29. On the November AWB deliberations, see "Conference with Bombardment Subcommittee, Air Force Aircraft and Weapons Board...," 18 November 1947, File "Appendix to Vol 1., XB-52 Airplane," Series 22, RG 18, NARA.

Several developments colored the discussions of the fate of the XB-52 in late 1947 and early 1948. One was that Joint Chiefs of Staff war planning, in which the Air Force participated, had clarified the likely characteristics of missions to be flown by the Strategic Air Command should war occur in the near future. The crises with Iran and Turkey in 1946 had led to the preparation of war plan Pincher and a succession of sub plans--Drumbeat (for defense of the Mediterranean), Moonrise (war in the Far East), and Deerland (defense of North America). In these plans, most attacks against the Soviet Union would be initiated from overseas bases, such as those in Great Britain.[30] This mode of execution was due to the fact that most of the airplanes capable of carrying atomic weapons were B-29s--the range of which necessitated the use of bases closer to the Soviet Union. Such factors limited the options for carrying out the plan of attack. Another consideration was the size and weight of the atomic payloads. In fall 1947 the Atomic Energy Commission (AEC) informed the Air Force "the size of the A-bomb would probably change prior to completion of this airplane," indicating that the plane could be smaller than the XB-52.[31] Air Force officials felt that properly designed the XB-52 could obviate the need for foreign bases, take advantage of smaller, lighter atomic weapons, and provide greater flexibility in fighting wars when production models of the plane became available in the early 1950s.

30. A synopsis on developments in war planning in this period is in Eduard Mark, "The War Scare of 1946 and Its Consequences," *Diplomatic History* 21 (1997):383-415.

31. Memo from H.A. Craig, DCS/M, to Director R&D, DCS/M, 15 January 1948, note 13.

Also in the background was the continuing tussle among President Truman, Congress, and the Air Force over service appropriations and size. President Truman appointed the Finletter Commission in summer 1947 as a response to the rising clamor from air power advocates and aircraft industry to increase government support of civilian and military air.[32] Congress was preparing to deliberate on these matters as well through hearings by the Brewster Committee. Through the fall both Congress and the Finletter Commission were gathering data and testimony. Both, by early 1948, would call for larger appropriations for the Air Force, among other things. But Truman deflected the pressure for increased budgets. In December 1947, the Bureau of the Budget cut the Air Force request for the FY 1949 budget, then under preparation, from $5.2 to $2.9 billion. Such a cut would affect procurement and service plans on the size of the force. The Air Force would now have to scale back from a 70-group size--which the Joint Chiefs had previously agreed was a minimum to meet defense and strategic bombing objectives--to 55 groups. Even then, funds would be inadequate to fully equip this reduced force. Air Force Secretary Symington was astounded by the Administration's approach. He complained to Secretary of Defense James Forrestal:

> Considering the requirements for the Marshall Plan...the rising favorable opinion of the Congress, the press, and the people with respect to the position of air power, and any common sense strategic concept as to how

32. RAND even gave an informal presentation of the bombing systems analysis to the Finletter Commission in October 1947, a further indication of the ways in which the RAND study intersected with procurement politics. See letter from A. Raymond to E. Bowles, 23 October 1947, note 27.

> to get at Russia, we are more shocked at this decision of the Bureau than at anything that has happened since we came into Government...[33]

Regardless of his distaste for Truman's position, Symington recognized he had to accept fiscal restraint in managing the service. In December the AWB was close to canceling the Boeing contract. A letter was sent to William Allen, president of Boeing, alerting him to this possibility. Allen protested and Symington made clear his position: "The importance of this project cannot be overemphasized. The resultant airplane may play a dominant role in the next war. For this reason we must be assured that we have the best possible design and configuration. There can be no compromise on this position."[34] Allen followed with a request to meet Air Force officials to plead the Boeing case. In February, Edward Wells, one of Boeing's lead engineers, reiterated his company's opposition to reopening the contracting process and offered a revamped design closer to the new requirements stipulated by the AWB. In the crucial area of gross weight Wells promised an aircraft of 285,000 to 300,000 pounds. Wells pointed out that proceeding in this way would save the service a year and a half in acquiring the plane, compared to a time-consuming industry wide competition. With this promise Air Force Under Secretary Arthur Barrows, representing Symington at the meeting, agreed to keep the contract with Boeing. Barrows and Symington knew, too, that if there was a

33. Memo from S. Symington to J. Forrestal, 16 December 1947, Folder "Secretary of the Air Force (1)," Carl Spaatz Papers, Library of Congress. On the same point see also letter from S. Symington to J. Webb, 16 December 1947, in the same folder.

34. Letter S. Symington to W. Allen, 26 January 1948, Folder "Secretary of the Air Force (2)," Carl Spaatz Papers, LOC.

competition, there was no guarantee that another company would do substantially better.[35]

The message of economy in procurement, while stoutly resisted by Symington and other air power advocates, deeply affected deliberations on choosing the next strategic bomber. Smaller budgets than the service desired placed a greater premium on making the right decision--even if it meant threatening to rescind a lucrative contract from a major manufacturer, who also was an ally in the call for larger military appropriations. Through the AWB and Symington, RAND and Paxson's bombing systems analysis were inextricably connected to the deliberations on the B-52 and to the larger context of the politics of procurement and military appropriations.

Through 1948 Paxson's study, the work of the AWB, and discussions over the XB-52 intertwined. In January the AWB met again. A summary of the meeting noted that: "All aircraft, weapons, and combat equipment (except photographic), required to carry the war plans of the USAF were discussed. The 1948 and 1949 procurement budget and a projected five-year procurement plan were considered, as well as the five-year research and development program."[36]

35. Boeing was also aided by the fact that the AMC, who let the original contract to the company, was a strong advocate for continuing the contract, perhaps as justification for the command's original decision. On the February 1948 meeting, see Maj. Gen. Partridge to Directorate, Research and Development, 15 June 1948, Folder "Appendix to Vol 1., XB-52 Airplane," Series 22, RG 18, NARA.

36. Memo from T. Power to Gen. Fairchild, 10 June 1948, Folder "334 Boards Misc, 1948, Vol. 2," Box 804, Series 1, RG 18, NARA.

The board decided not to meet again until the end of 1948 or early 1949, because "it would be inadvisable to change the agreed programs too often."[37]

Paxson continued to gather data on three major components of his research: aircraft capabilities, attrition, and target coverage. He also continued to give briefings, including one to the AEC in July. The reason for this was to coordinate the design of a bomber with likely developments in the size and yield of atomic weapons.[38] Within the Air Force there was disagreement on the defensive armament needed for a strategic bomber. The conflict over the amount of such armament reflected different perceptions of what was crucial in assuring a successful mission. More armament provided more protection for the crew and perhaps a better chance of resisting enemy attacks. Less armament resulted in less weight and an aircraft of longer range and greater speed. Paxson and RAND were asked to evaluate this question as part of the larger study.[39]

But the problems with the XB-52 would not go away. Despite Boeing's promise in February to meet the revised performance standards, by June their design once again deviated from Air Force specifications. General Partridge, who

37. Ibid.

38. See memo from L.C. Craigie to F. Collbohm, 24 May 1948, Folder "334 Boards Misc, 1948, Vol. 2," Box 804, Series 1, RG 18, and memo from J.G. Armstrong to K.E. Fields, 8 July 1948, Folder "337 Conferences, 1948, Vol. 3," Box 806, Series 1, RG 18, NARA.

39. Letter from L.C. Craigie to F. Collbohm, 4 August 1948, and letter from F. Collbohm to L.C. Craigie, 13 August 1948, both in Folder "380 Projects, 1948, Vol. 4," Box 817, Series 1, RG 18, NARA.

oversaw the formulation of aircraft requirements, noted in June that the latest data from Boeing indicated the gross weight had risen back up to 360,000 pounds. The new Boeing design, Partridge acidly pointed out, looked a lot like a previous version:

> The similarity would lead to the belief that the Boeing Company is giving us the old B-52 with a new coat of paint. Should this be the case, the intent of the new characteristics will have been defeated, and in addition, it would appear that Boeing secured the new contract, without competition, on the basis of untenable performance figures.[40]

Despite Partridges's concerns neither the AWB or RAND seems to have revisited the question of Boeing's work on the XB-52 for the rest of the year.

The Bombing Systems Analysis in a New Context

Events in 1948 again reconfigured the context within which RAND and the Air Force viewed Paxson's bombing systems analysis. Confrontations with the Soviets in 1946 and 1947 and rising tensions in spring 1948 over Berlin motivated the JCS to revise its 1946 Pincher war plan. In May the JCS prepared Joint Emergency War Plan "Halfmoon." The Air Force strategic offensive portion of the plan, code named "Harrow," detailed an attack on 20 Soviet cities with 50 atomic bombs. Air Force planners expected such an attack to cause "immediate paralysis of at least 50 percent of Soviet industry." In December 1948 war plan "Trojan" (soon renamed "Fleetwood") succeeded Halfmoon and called for destruction of 70 Soviet cities with 133 atomic bombs. In August 1949 the Soviets successfully detonated their first atomic weapon. In October the JCS produced a new

40. Memo from Maj. Gen. Partridge to Directorate, Research and Development, 15 June 1948, note 35.

plan, "Offtackle," expanding the attack to 104 urban targets with 220 atomic bombs in a first wave assault, with 72 bombs in reserve for a second onslaught.[41]

This escalation in war plans was interconnected with several developments. The string of confrontations with the Soviets has already been mentioned. Also germane were increases in the number of atomic weapons and AEC improvements in design and production of new devices. The atomic stockpile increased from 2 weapons at the end of 1945, to 9 in July 1946, to 13 in July 1947, and to 50 in July 1948. Demobilization had affected the ability of the AEC to develop new designs and produce fissionable material for weapons. These difficulties led to a perception within the military that the amount of fissionable material available was limited and, hence, that the atomic stockpile could only slowly increase. Atomic bombs seemed to be a scarce resource. In 1948 this situation changed substantially. After tests of new designs at Eniwetok, the AEC could promise bombs that were more efficient (less material would have the same destructive power) and easier to produce. JCS and Air Force planners could expect a stockpile of 400 weapons by 1951, with increases to follow.[42]

41. The most succinct and insightful account of these developments is David Rosenberg, "The American Atomic Strategy and the Hydrogen Bomb Decision," *Journal of American History* 66 (1979):62-87, and also his "Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960," *International Security* 7 (1983):3-71. The quote is from Rosenberg, "The American Atomic Strategy...," p. 68. Rosenberg also notes that almost all the weapons available prior to 1950 were of the same design as the bomb dropped on Nagasaki. These bombs were an unwieldy 10,000 pounds, were inefficient in their use of fissionable material, and took 25 to 40 men over two days to assemble for use.

42. On the number of atomic bombs in the arsenal see Rosenberg, "The American Strategy..." and "The Origins of Overkill...," cited in note 41. On the AEC and the 1948 "Sandstone" tests at Eniwetok see Richard G. Hewlett and Francis Duncan, *A History of the United States Atomic Energy Commission,* Volume Two: *Atomic Shield, 1947-1952* (University Park, PA: Pennsylvania State University Press, 1969), chapters 5-7.

War plans featuring an atomic air offensive also were a product of the limits President Truman imposed on military spending. In July 1948 Truman imposed a budget ceiling of $14.4 billion for military appropriations in fiscal year 1950, substantially less than the $21-23 billion that the services and the JCS argued was necessary.[43] According to military planners, lower levels of funding precluded a defense using conventional forces deployed in Europe against Soviet threats. Instead, in light of the Truman budgets, United States plans had to rely on the less expensive alternative of deterring the Soviets with strategic bombers and atomic weapons.[44]

A change in the leadership of the Air Force's SAC solidified the increasing commitment to war plans emphasizing bombers and atomic bombs. In October 1948, Curtis LeMay assumed command of SAC, after a stint in Europe which included leading the airlift into Berlin in summer 1948. The Army Air Forces established SAC in March 1946, but under General George Kenney the command had a troubled beginning. Only about 30 B-29s fitted to deliver atomic weapons

43. In the two prior months Truman succumbed to intense pressure from Congress and the services, agreeing to sign a $3.1 billion dollar supplemental appropriation for FY 1949 military spending, much of it for aircraft procurement. Congress passed an additional $822 million authorization for aircraft purchases which Truman impounded. Truman was then determined to restrain FY 1950 spending. A lucid account of the military budget wars is Steven L Rearden, *History of the Office of the Secretary of Defense,* Volume 1: *The Formative Years, 1947-1950* (Washington, D.C.: Historical Office, OSD, 1984), chapters 11-12.

44. This is Rosenberg's argument in "The Hydrogen Bomb Decision...," note 41.

were available in 1947. More generally, the readiness of the strategic bombing groups was suspect. In late December 44 B-29s were in Europe and 18 of them were "non-operational due to corrosion...and 26 more are expected to become non-operational after 1 January 1948."[45] Moreover, the special bomb assembly teams were also understaffed and ill-prepared to perform their crucial role.[46] When LeMay assumed command he argued forcefully for giving priority to the strategic bombing mission, reinforcing the direction of war planning. He stressed readying more planes for the atomic mission. Two months after his arrival 60 planes could fulfill such missions, by mid 1950 250 planes (comprised of B-29s, B-50s, and B-36s) were at hand.[47] LeMay also quickly became a staunch advocate of the B-52 program as the best hope to realize a powerful strategic force in the years ahead.

The escalating pace of war planning and of readying aircraft and bombs to confront the Soviet threat troubled Secretary of Defense Forrestal. In October 1948 he asked the JCS to study whether the Air Force could actually succeed in executing the planned air offensives--get the planes and bombs through Soviet defenses to designated targets. The JCS first referred the matter to the Air Force, which offered a preliminary response in December and a complete report in February 1949. Not surprisingly, the service concluded it could execute the strategic offensive as called for by war plan Fleetwood. The Navy representative on the

45. Memo from O.P. Weyland to DCS/O, 1 December 1947, Folder "Organization," Carl Spaatz Papers, Library of Congress.

46. On this point see note 39.

47. On the number of planes see Rosenberg, "The American Strategy..." and "The Origins of Overkill...," cited in note 41.

JCS, Admiral Denfield, dissented from this conclusion--doubtful of Air Force confidence and fearful that support for the air campaign would weaken Navy claims to a role in delivering atomic bombs. The conflict over whether the Air Force would have a monopoly over the delivery of atomic weapons or whether the Navy would be included had been intensifying since the end of the war. In October 1949 this dispute erupted in the "revolt of the admirals" as the comparative merits of the B-36 and Navy supercarriers were debated in Congress.[48]

Before the October Navy-Air Force confrontation the JCS had asked its Weapons Systems Evaluation Group (WSEG) in April 1949 to review the question of the feasibility of the air campaign. The WSEG had been established in late 1948, at Vannevar Bush's instigation, and operated under the joint auspices of the JCS and the Research and Development Board (RDB).[49] Its charge was to perform

48. On these points see Steven L. Rearden, *History of the Office of the Secretary of Defense,* Volume 1: *The Formative Years, 1947-1950,* note 43, and Gregg Herken, *The Winning Weapon* (New York: Alfred Knopf, 1980), chapters 12-15.

49. In spring 1948 the RDB appointed a special board to consider "the problem of overall weapons system evaluation." The four-member board included Lloyd Berkner, a close associate of Bush and former Executive Director of the JRDB (the RDB predecessor) and Alfred Loomis, who in the same time period was assisting Rowan Gaither in establishing RAND as a nonprofit corporation. Their recommendation in May led to the creation of the WSEG later in the year. Their accompanying report noted that: "The defense program of the United States suffers from the lack of an adequate mechanism for evaluating with vigorous, impartial scientific method the relative merits of various military programs and weapons systems, present and future. It is true that within each of the three Services scientific evaluation groups are currently engaged in studying weapons and systems of weapons and their probable future performance, but there is no agency capable of and responsible for applying this same type of thinking to *inter-service* problems." In Revised Draft "Weapons Systems Evaluation: Report of the Ad Hoc Committee," 6 May 1948, Folder "W.E. RAND: Study and Evaluation of Weapons Systems," Box 1, E.L. Bowles Papers, NASM. The administration of the WSEG, under joint RDB and JCS auspices, reflected Bush's distrust that the military alone could evaluate weapons with "vigorous, impartial scientific method."

studies, similar in cast to RAND's work for the Air Force, to inform JCS decision making. Army General J.E. Hull was director and Philip Morse, a Massachusetts Institute of Technology (MIT) professor and a member of the RAND Board of Trustees, served as deputy director. General Hull sent WSEG's evaluation, the group's very first study, to the JCS in early February 1950.[50]

In fall 1948, at the same time he was asking the JCS to study one aspect of strategic air operations, Forrestal appointed an ad hoc committee, led by Air Force Lt. General Hubert Harmon and composed of two officers each from the three services, to examine the actual damage expected from an atomic attack and the effects it would have on the Soviet Union. Their report was complete in May 1949.

All of these events in 1948 and 1949 intersected with Paxson' bombing systems analysis. The heightened importance of the strategic air campaign gave additional significance to Paxson's study in several ways. Assuming its successful completion, the study could demonstrate the care with which the Air Force had evaluated its contribution to the air campaign. The three central features of Paxson's analysis--selecting the "best system," modeling Soviet defenses and their effect on the bombing campaign, and the problem of target coverage--were integral to concerns of LeMay, Forrestal, the WSEG, and the JCS.

50. Commonly called WSEG Report No. 1 or the "Evaluation of the Effectiveness of the Strategic Air Operatons," but in JCS numerical coding the report is referred to as JCS 1952/11, 10 February 1950, Folder "373 (10-23-48) B.P. Pt. 2c, 1948-1950 Files," RG 218, NARA.

In addition, the question of procuring the B-52 was still unresolved and remained intertwined with Paxson's study and with the larger context of discussion. The Air Force and RAND both stood to benefit from a decision--pro or con--based on a close analysis of aircraft state-of-the-art and of the strategic mission. Deliberations on the B-52 program, though, moved to a new venue within the Air Force. In spring 1948 General Hoyt Vandenburg replaced General Carl Spaatz as Chief of Staff and moved to reorganize the AWB. The original structure had fifteen members, which, in Vandenberg's eyes, proved cumbersome for making the many, difficult decisions facing the service in research, development, and procurement. The new group, the Senior Officers Board, was composed of just four members--Vice Chief of Staff Muir Fairchild, the Deputy Chiefs of Staff for Operations and Materiel, and the Commanding General, AMC. In explaining his reasons, Vandenberg, sounding like Edward Bowles, said: "In the final analysis, the top command of the Air Force is responsible for the weapons with which it will fight the war."[51] The Senior Officers Board started work at the end of December 1948. Paxson's study would be presented to the service's "top command" in 1949 and the first half of 1950 and incorporated into the broader complex of questions on the strategic air campaign, budgets, and procurement.

Finally, Truman's resolve to restrain military budgets in fiscal years 1950 and 1951 meant that the questions of what kinds and how many aircraft to procure increased in importance--a point explicitly addressed in Paxson's analysis. And as

51. In Futrell, *Ideas, Concepts, Doctrine*, note 10, p. 108.

Air Force budgets stagnated, RAND's own funding was scrutinized more closely. RAND needed Paxson's study to demonstrate that the military worth agenda and systems analysis could provide concrete tools and results that served Air Force interests. Such success would be crucial to the continuation of the new corporation. Arnold's initial 1946 $10 million dollar set-aside for RAND was nearly exhausted, and the RAND budget was now part of the annual federal give-and-take over spending priorities and appropriations.

<u>The Strategic Bombing Systems Analysis, 1949</u>

The complex of issues surrounding Paxson's study converged in 1949 and 1950. At the end of December of 1948 and in the first days of 1949 the newly composed Senior Officers Board met to review the entire Air Force research, development, and production program--in light of Truman's FY 1950 $14.4 billion budget for the services and the current JCS war plan, Fleetwood. The 1948 and 1949 FY budgets had forced the JCS and the Air Force to reduce the size of the service to 55 from 70 groups. The 70-group figure had been mutually agreed on at end of the war by the Army Air Forces, the War Department, and the JCS as the minimum size force to fulfill strategic and other missions.[52] Truman's FY 1950 budget forced another reduction in size--down to 48 groups. In reporting to Secretary Symington, the Board noted that in these circumstances:

52. This figure was necessarily a matter of judgment. On Air Force planning assumptions to arrive at this force level see Perry McCoy Smith, *The Air Force Plans for Peace, 1943-1945* (Baltimore: Johns Hopkins University Press, 1970). For background on the concept of the group see Herman S. Wolk, *Planning and Organizing the Postwar Air Force, 1943-1947* (Washington, D.C.: Office of Air Force History, 1984). According to Wolk, p. 31, "the group, made up of three or four squadrons and support elements, was the basic AAF combat unit. The group would consist of 35-105 planes and from one thousand to two thousand men."

> The launching of an atomic offensive and the defense of the Western Hemisphere and the essential base areas from which to launch the atomic offensive must be considered as the primary mission of the Air Force and must be given the greatest consideration and priority in arriving at the proper composition of the 48 Group Program under the $14.4 billion concept of the Joint Chiefs of Staff.[53]

In a review of SAC needs before the board, Curtis LeMay and Thomas Powers, LeMay's deputy, argued for continuation of the B-52 program, including a change from reciprocating to turbojet engines to increase the aircraft's speed. The SAC presenters noted "the B-52 appears to be the aircraft most likely to satisfy our requirements four to five years hence. Therefore, we feel that its development should be pushed at higher priority than any other very long range bomber being considered."[54] The Paxson study was predicated on the assumption that the Air Force (and RAND) would be best served by a careful analysis of the options for conducting a strategic campaign. The AWB shared this view. LeMay, after two months on the job at SAC, had reached his own conclusion: "That the Strategic Air Command be equipped as promptly as possible with high-speed, long range aircraft capable of bombing targets in the USSR from bases on this continent, without resorting to air-to-air refueling."[55] The board seemed to tacitly accept LeMay's viewpoint, never raising the numerous concerns over the B-52 expressed by AWB in the previous months.

53. Memo from J. McNarney to Secretary of the Air Force, 13 January 1949, Folder "McNarney Report Recommendations," p. 2, Series 165, RG 341, NARA

54. Transcript, 3 January 1949, Folder "Aircraft Weapons Board Proceedings," p. 399, Entry 450, RG 341, NARA. This document is a verbatim transcription of the presentations to and discussions of the Senior Officers Board.

55. Ibid, p. 398. These comments were made by Thomas Powers in support of LeMay's presentation.

The politics of procurement, service demands for a larger budget, and Truman's check on such an increase were inescapable undercurrents in the discussions. LeMay, especially, pressed the case for resisting Truman's position and, if that could not be done, then for programming the Air Force budget so that SAC would get twenty of the service's 48 group strength. General McNarney, Commanding General of AMC and chair of the board in the absence of Vice Chief of Staff Fairchild, while sympathetic to LeMay's concerns, replied that neither option was possible and would not be supported. Fourteen groups were the most LeMay would get. McNarney noted:

> I don't believe there is much utility at this time in stressing the fact that you should have more groups. It is well known to everybody in the Air Force, to Mr. Forrestal and the President, and probably to the Congress, but we are forced right now to plan on a 48 group program of the composition shown here...what we want you to tell us this morning is what you can do, and how you are going to do it, with the 14 groups; what types of airplanes; whether you are going to do it now, tomorrow, or the day after tomorrow.[56]

The board accepted the limits imposed by Truman and made clear that LeMay would as well.

They also recognized the sensitive position they occupied, especially on how their choices in composing the 48-group force might affect procurement and the larger political context. Generals Powers and McNarney reminded "everybody on the security angle of this whole business...any premature discussions outside this room would probably compromise the whole situation." McNarney emphasized

56. Ibid, p. 395.

"everyone should be very careful. We do not discuss what goes on in this room with anyone outside this room."[57] One of their decisions merited this caution. LeMay's promptings on strengthening strategic bombing capabilities led the board to recommend increasing the procurement of B-36s, the longest range bomber then in production--and a favorite target of the Navy sure to provoke interservice divisiveness. The board forwarded this decision to Secretary of Defense Forrestal, Chief of Staff Vandenberg, and Symington--all of whom reviewed and had final authority to approve board recommendations. Forrestal asked the board to review its B-36 decision, which it did in February 1949.

RAND, too, felt the sting of fiscal limitations. RAND's budget had increased sharply as the organization built up and undertook a greater number of studies for the Air Force. In its first year of operation RAND spent less than $1 million, nearly half of that on subcontracts. Almost three years later as the board met in January 1949, RAND was spending at a rate of $3 million annually. RAND was close to exhausting the original $10 million set aside for the project. Future budgets would now be evaluated within the context of the annual appropriations process. Recent Air Force requests for studies--principally from the Air Staff, AMC, and SAC--promised to add another $2.6 million to the corporation's budget, for a total of $5.6 million annually. Like other parts of the service budget, expenditures for research and development were held in check. The FY 1950 budget allowed the service $205 million for research and development. But $87 million of these funds actually supported aircraft production. Of the remainder,

57. Ibid, p. 397.

$97 million funded new development initiatives and $20 million underwrote more general research. RAND's budget came out of this last category and, without any change in projected expenditures, would consume more than a quarter of these funds. The board found this prospect unacceptable; they proposed a $3 million budget.

The old tensions between RAND and the AMC, rooted in Bowles's conception of RAND as a counterweight to AMC's influence in service research and development matters, resurfaced. McNarney, as AMC commander and as head of the board, was especially harsh:

> I think with this reorganization of RAND and putting this fellow Collbohm off on his own, he is out shooting at the blue; he is an empire builder of the worst kind...[58]

For McNarney and others the severing of RAND's connection to Douglas had raised a measure of distrust. Without Douglas's backing, they had a clearer appreciation, as did RAND, that the number and size of studies would determine the corporation's funding from the Air Force. Members were particularly concerned about RAND's apparent lack of progress in evaluating the air defense of the continental United States. The Air Force, which had primary responsibility for this task, had asked RAND to investigate the issue in early 1947. The military, Congress, and others expressed increasing concern over the military's ability to defend against an air attack as confrontations with the Soviets intensified. At the time of the Senior Officers Board meeting, the Berlin airlift, begun in summer 1948, was still underway. RAND had difficulty organizing the air defense project,

58. Ibid, p. 296.

which featured as many complexities as the bombing systems analysis. For RAND management, the air defense study was a companion piece to Paxson's work--they featured complementary technical issues and both were seen as the foundational exemplars of systems analysis. Indeed, until early 1950 Paxson also led the effort on the defense study, indicating the challenges RAND faced in finding individuals attuned to the military-worth thinking of Williams and adept at leading a systems analysis.

One Senior Board member ventured that "I, personally, after having looked at them from air defense point of view, would like to say that I think that they are a bunch of people who if not employed in RAND would be employed as assistant professors in physics in small colleges and that they are not going to come out with the answers that we expect from them....I don't think they are the people that are going to produce the answer, and I think $3 million is $2.5 million too much."[59] Referring to Paxson's study, another thought that "they have been working feverishly at this heavy bomber project. The Board has made a decision now on the bomber that there won't be any new bomber for a long time. It seems to me they can slow down...." The Board member was referring to preliminary thinking on a successor bomber to the B-52 and, of course, had missed the focus of Paxson's effort.

The board discussion on RAND reflected a problem that John Williams and others had considered earlier: ensuring proper mechanisms of communication

59. Ibid, p. 302.

between RAND researchers and the Air Staff. The coordination of social resources that systems analysis promised would fail from the beginning if such mechanisms were not established. The quarterly briefings between RAND and the Air Staff, separate briefings for individual projects, the progress reports, published studies, and the working liaisons were apparently not adequately communicating the substance of the RAND effort. The Senior Officers Board, at this point, had misconceptions about the RAND research program and a near complete lack of appreciation of the objectives of the military worth and systems analysis initiatives. In part, this may have been due to constant rotating of officers in and out of key positions. For RAND, there were always new faces to educate. In the case of the AMC's McNarney, there perhaps also was resistance to the messenger and the message. Moreover, the board did not have a comprehensive view of all the work the Air Force had asked RAND to undertake. Almost all of the RAND research effort resulted from service requests to examine questions ranging from discrete technical problems to major studies such as the air defense and bombing analyses.

RAND did have allies, especially General Donald Putt, head of the Research and Development Directorate on the Air Staff. After the December-January meetings, RAND pleaded their case with Vice Chief of Staff Fairchild, who had been absent from the board's deliberations. Collbohm suggested that RAND, if held to a $3 million ceiling, would seek support elsewhere, perhaps from the Navy or Army. If the corporation was to attract and keep good personnel--the most valuable asset of the organization--more money was needed. The board met again in February 1949, at the behest of Forrestal, to clarify some of its decisions--

especially as to increased funding for the B-36. RAND, once again, was a topic. Collbohm's not-so-subtle threat to dilute the Air Force role in RAND generated an interesting discussion. Some members of the board felt the Air Force should, as RAND preferred, preserve the Air Force "monopoly" on the corporation's services. This would keep the Air Force on a level with the Army and the Navy, who had their own operations analysis groups. This reasoning was not persuasive to McNarney, who still distrusted Collbohm's motives. "Knowing Mr. Collbohm," McNarney said, "if you think that what he said was what he had in the back of his mind, I am not so sure."[60] As an exclamation point to his critique, McNarney added that "nobody pays any attention to what they say anyway."

As a rejoinder, Don Putt laid out some of the contributions RAND had made to the Air Staff and commands. The Board also seemed to have a better grasp that the primary engine driving RAND expenditures was the constant stream of service study requests. But the tenor of the discussion shifted when Putt pointed out that RAND was one of their best resources in dealing with WSEG, the RDB, and the JCS on weapons evaluation issues--and that the corporation had already established its own network of connections to these groups. Forrestal's request to review the strategic air campaign and the work of the Harmon committee, although not explicitly mentioned, were certainly in the background. One member noted that RAND could be "a potent factor in the deliberations of the weapons evaluation group." McNarney, perhaps thinking of Forrestal's queries and the Navy's

60. Report of Senior Officers Board, 21 February 1949, p. 60, Box 5, Entry 450, RG 341, NARA.

criticisms, reversed direction and stated "I'd say we better start following RANDrather than ignoring their recommendations."[61] The board then decided to increase RAND's funding to $4 million and ask the Air Force comptroller to audit the corporation's budget to arrive at an accurate appraisal of their expenditures and of their commitments to conduct studies requested by the service.

The board had second thoughts on the aircraft program, too. While they held to their recommendation to increase B-36 procurements, they felt less certain about the B-52. Fairchild Aircraft Company had proposed an alternate design for a long-range heavy bomber. But the budget squeeze did not allow the development of another major aircraft. Choosing another approach meant canceling the B-52 and incurring further delays in acquiring a bomber to succeed the B-29s, B-50s, and B-36s. But with competition from the Navy for the strategic role, the board did not want to make the wrong choice. Vice Chief Fairchild made it clear: "The Chief [Vandenberg] is concerned that by utilizing the conventional approach [the B-52], we may be overlooking some unconventional approaches which others will take and suddenly find ourselves definitely out of the picture on the all important matter of delivering the A bomb."[62] Fairchild's "others" referred to the Navy, then promoting a super aircraft carrier as an alternative to long-range bombers such as the B-36 and B-52.

61. Ibid, p. 75.

62. Ibid, p. 95.

Mindful of interservice rivalry and the uncertainties of how best to plan for near term and future strategic air war, the board concluded their meetings more favorably disposed to RAND's work. The board's deliberations from December 1948 through February 1949 were indicative of the difficulties of and tensions over coordinating budgets, war plans, readiness, and procurements. The AWB earlier had found RAND's systems analysis and related work integral to their deliberations. The Senior Officers Board, a year later, seemed to miss the possible import of RAND's work until it was situated in the context of interservice rivalry. The board's limited endorsement emphasized for Collbohm and Paxson the need to complete the study. Until then the idea that research on air warfare could help to organize the complex of political and technical issues confronting the Air Force would be an inside-corporate hope. And until then, RAND would remain unproven.

Paxson's work, though, was only growing more complicated. After the Eniwetok atomic tests in 1948, the AEC could offer a range of bomb sizes and weights. Initially, Paxson assumed that the atomic bombs in his study would be the same as those used on Nagasaki in 1945--bulky and approximately 10,000 pounds. With the AEC improvements bomb weight and explosive force became important variables, especially after a June 1949 Air Staff request to consider these implications. As noted before, RAND's background studies had demonstrated that small increases in payload weight caused substantial increases in overall aircraft weight--which in turn resulted in marked increases in cost. The possibility of conducting the air campaign with bombs less than 10,000 pounds opened the way to aircraft smaller and lighter than the B-36 and the B-52.

The state of engine technology was also changing. By 1949 it was clear that jet technology would replace reciprocating engines. The B-47 medium bomber, built by Boeing and then close to production, incorporated turbojets. LeMay wanted such engines for the B-52 as well. Also in development were turboprop engines in which a jet turbine powered a propeller. The turboprop provided less speed than a turbojet, but better efficiency and range.

Another difficulty was finding reliable assumptions on the extent and quality of Soviet air defenses. Forrestal's concern over this point had been one of his primary motivations in asking for a review of the strategic air campaign. Paxson received his data on enemy air defenses from the Air Force Air Intelligence Branch, but the JCS had their own educated guesses. Regardless, such information was sparse and unreliable. Moreover, there were questions on the criteria for selecting targets, the damage to be expected from attacks, and the significance of that damage. These issues had been the focus of the Harmon Committee, also appointed by Forrestal (noted above), which, in turn, had motivated a review within RAND, called the Strategic Air Project (STRAP), to provide assistance to Paxson's work.[63]

Paxson's work also bogged down under the burden of executing the numerous calculations required by the analysis. This situation forced Paxson to

63. On STRAP see, for example, "STRAP Committee Minutes of Meeting," 5 May 1949, Folder "Miscellaneous, 1949," F.R. Collbohm Papers, RAND; and "Working Paper," 14 January 1949, ibid; and "STRAP Conference: Summary of Economic Panel Discussions," 12 August 1949, RAND Publication D-616.

limit his study to a "static" campaign--an analysis of only the first wave of attack called for in war plans.[64] Analysis of subsequent phases of attack over ensuing days and weeks would have to wait. He also simplified the study in another respect: he dropped consideration of the use of intermediate bases, focusing on aircraft that could fly intercontinental distances either directly or with midair refueling. This change undoubtedly reflected the preference of LeMay and the Air Staff for conducting the air campaign from bases in the United States.[65]

Paxson also clarified a point that had been ambiguous in earlier versions of the study: the analysis focused on a hypothetical air campaign in the years 1956-1960. This time frame reflected the cycle of research, development, production, and then obsolescence of the "best" aircraft system to be identified by the analysis--1956 would be the earliest date such an airplane could be available; 1960 the date by which its usefulness would be over. Extrapolating these few years ahead also raised new uncertainties in variables such as the future state of Soviet defenses as well as changes in bomb technology.[66] This change, too, made direct

64. This would be cited by LeMay and other critics of the study as a crucial shortcoming that undermined the validity of Paxson's analysis. See discussion below.

65. LeMay was adamant on this point. He even resisted the use of aerial refueling, accepting it only as a temporary measure to achieve long-distance bombing capabilities. The clear goal was an aircraft that could execute the air campaign from United States soil, without using intermediate bases or aerial refueling. See, for example, memo from Lt. Col. J. Maxwell to the Record, 22 November 1949, "B-52 Conference," Folder "B-RB-52," Series 170, RG 341, NARA.

66. On Paxson's efforts to develop assumptions on Soviet air defenses for the period of his study see, for example, memo from Col. J. Schweizer, Directorate of Intelligence, to Director of R&D, 26 August 1949, "Estimate of Soviet Air Defense Capabilities in 1956," Folder "2-8700 to 2-8799," Series 214, RG 341, NARA. The memo declares that "it should be carefully noted that intelligence as to current Soviet equipment, capabilities, and intentions is far from complete. The extension of estimates of these factors to a period eight years in the future entails

correlation of the RAND study with service deliberations on the B-52 more problematic. If Boeing could deliver the aircraft as promised, it would enter the SAC force in 1953 or 1954--several years before the RAND alternative. The schedule for aircraft development implied in the RAND study was, thus, out of phase with Air Staff decision making.[67]

As Paxson grappled with these problems in 1949, both he and Collbohm knew that they had to share their work with Curtis LeMay. LeMay had already gone on record in support of the B-52 and would closely scrutinize any RAND recommendation. They had an opportunity to draw LeMay into their work in June when the Air Staff asked RAND to consider what bomb weights and destructive potentials would best meet the requirements of the air campaign.[68] Collbohm and Paxson immediately recognized that this important question could only properly be

the establishment of a number of hypotheses each one of which is open to serious question. Of paramount importance and least obvious is the factor of Soviet intentions." The memo was generated in response to a request for data from Paxson on expected 1956 capabilities. Judging from the tenor of the memo, it was not a question the Directorate of Intelligence had previously addressed. See also memo from Col. J. Schweizer, Directorate of Intelligence, to Director of R&D, 19 September 1949, Folder "2-9100 to 2-9199," Series 214, RG 341, NARA.

67. This was another point that LeMay soon would exploit in critiquing Paxson's study. LeMay's position was that SAC "has a definite requirement for the B-52 by 1954, that the B-36 will not meet those requirements, and that SAC could not wait until 1957 for a replacement for the B-36." Memo from Lt. Col. Maxwell, 22 November 1949, "B-52 Conference," note 65.

68. The Air Force first had requested RAND to research these issues in July 1948, apparently after the the AEC Sandstone atomic tests indicated the feasibility of varying bomb sizes and yields. On the request to RAND see Memorandum "Notes Relating to Proposed Project RAND Atomic Weapons Study Program," undated, unfoldered, Box 5, Brownlee Haydon Papers, RAND. The memorandum is an extract from a 2 July 1948 Air Force letter to RAND.

addressed in the context of the bombing system analysis. The request prompted them to change the problem statement for the study:

> Given a fixed amount of fissile material and a fixed sum of money with which to procure, operate, and maintain a strategic striking force at strength for a 4-year period, specify the atomic bombs and aircraft which will maximize damage of an initial atomic bombing attack.[69]

Given the travails over the RAND budget, Collbohm and Paxson rushed to provide an answer. In mid July the RAND newsletter noted breezily that: "During the last two weeks RAND has been conducting a VQDI study (very quick and dirty indeed) of an aerial bombing system. This is to enable us to make some recommendations to the Air Force...Ed Paxson has been conducting a chorus of many voices; most of the people in the building are involved at least indirectly. And the computing machines have demonstrated again that heat is not their major output."[70]

The records only partially suggest the full content of RAND's recommendations on the issue of bomb size and its correlation with the other factors in the Paxson study. Collbohm and Paxson met with the Air Staff in late July to share their research and once again try to persuade LeMay of the merit of their analysis. In introductory remarks Collbohm offered that "we have worked very hard over the past six weeks on this problem [preferred bomb size]....In view of the urgency of

69. This reformulation of the problem was presented in a summary of the study in *The RANDom news*, Vol. III, No. 2, January-March 1950, p. 2. *The RANDom News* was an internal newsletter of the corporation, classified as "secret" during this time period. The reference to a "fixed amount of fissile material" indicated that Paxson still was regarding atomic weapons as a scarce resource, despite assurances from the AEC that the nuclear stockpile would increase substantially in the early 1950s.

70. *The RANDom News*, Vol. II, no.15, 22 July 1949, p. 2.

the requirement for a decision on future bomb development, we have attempted using the skills and efforts of our entire staff, to take a first cut at a real bombing systems analysis." Collbohm tried to qualify RAND's effort by noting that "RAND is not primarily concerned with the detailed characteristics of existing instrumentalities."[71] But, of course, the corporation was involved in such assessments in at least two ways--as part of the background research necessary for analyzing and comparing existing, near-term, and future technologies, as well as by virtue of the political context of Air Force procurement. The service kept asking for such assistance to manage its own internal disagreements and as a tool to deal with larger policy conflicts over budgets and service roles and missions. Aware of this larger context Collbohm stressed that RAND's presentation was in "no sense a formal presentation; it is in the nature of a consultation....The real reason why we wanted to meet with you today, and in particular why we were especially anxious that Gen. LeMay be present personally, was our feeling that we badly needed guidance and advice from the most experienced commanders and operational people in the Air Force."[72]

Collbohm was in an awkward position. The study was not ready--either analytically or politically. From the earlier budget deliberations Collbohm knew that, if the analysis and RAND were to be a success, then service leaders--particularly LeMay--would have to become participants and allies in the prepara-

71. F.R. Collbohm, "Draft of Suggested Introduction for Meeting of July 26th," pp. 2-3, Folder "Miscellaneous, 1949," F.R. Collbohm Papers, RAND.

72. Ibid, pp. 4-5.

tion of the study. But the Air Staff wanted guidance immediately on some issues. It appears Collbohm and Paxson were reluctant to specify a preferred bomb size because the question was so interconnected with other matters--the B-52, the reviews of the strategic air offensive, and rivalries with the Navy. In discussing the situation with Putt, their closest ally and working partner on the Air Staff, Collbohm agreed "that any study which might tend to indicate changes in Air Force policy on matters other than bomb development should be taken up within the family first."[73] This was such a family get-together.

At the July meeting with the Air Staff and LeMay, Paxson presented the study, the structure of which had remained much the same over 1947 and 1948. He offered as tentative conclusions that, depending on bombing accuracy and enemy defense fighter capabilities, the question of preferred bomb size might yield widely different answers. While this answer might have seemed evasive or simply not surprising, it reflected Paxson's extreme rigor in identifying, assessing, and assigning values to the numerous variables of his study. Bombing accuracy depended on the speed and altitude of the aircraft, the quality of the crew, and

73. Ibid, p. 5. As part of RAND's preparations for this briefing Gene Root examined the effect of lower bomb weights on the B-52 and B-47 designs. As noted before, RAND had developed general formulae for correlating gross aircraft weight with payload capacity. As part of these studies RAND had calculated that for a turbojet B-52, "if the design bombload is reduced to 5,000 pounds from 10,000 pounds initial gross weight can be decreased 57,000 pounds or a factor of approximately 11 pounds of gross weight for every pound of bombs." Apparently by summer 1949 Root and other aircraft design experts at RAND were uncertain on whether their original formulae were still accurate. Hence, RAND had difficulty in assessing the impact of a possible change in bomb weights on the relative merits of Paxson's aircraft versus the B-52. For the quote and a disccusion of these points see letter from Lt. Col. Harden to G. Root, 6 July 1949, Folder "B-52, 1949," Series 170, RG 341, NARA.

other variables, many of which remained unsettled. The predominant outcomes of the meeting were a promise to produce "in a month or so" a genuine first draft of the analysis and a hope, from RAND's perspective, that this exercise in bridge building would lead to a shared commitment to RAND's research.

Immediately after the July meeting Collbohm met with Frank Everest, Assistant Deputy Chief of Staff for Operations, and several other generals to discuss the relation of RAND's work to the B-36 controversy with the Navy and to the WSEG study on the strategic air offensive just getting underway. Collbohm's summaries of these meetings show both his caution and enthusiasm. He wanted to be sure that RAND handled the politics in a manner consistent with Air Force positions, but also saw the ways in which the study might help to recast the complex of technical and political relations confronting the corporation and the service. One general, according to Collbohm, wanted a copy of Paxson's presentation "right away, because this was going to change all his plans." Collbohm claimed that "when I was talking to Everest and so on it was quite plain they were considering--of course, depending on the final answers anyway--and implied in conversation numerous times the fact that they may be in for complete changes in Air Force doctrine almost immediately with regards to future procurement and what goes with that."[74]

74. Transcription, "Report by F.R. Collbohm on Trip to Washington and SAC, Week of 25 July 1949, pp. 5-6, Folder "Dictaphone Transcriptions, 1949," F.R. Collbohm Papers, RAND.

This apparent interest in Paxson's study on the part of some on the Air Staff stemmed from an observation he had shared with the AWB in 1947: assuming limited budgets the best allocation of resources might be to procure the most airplanes rather than the best airplanes. The study's approach was to fix the total budget available and vary the pounds of aircraft purchased to assess the best outcome in terms of targets destroyed. With Truman's steadfastness on budgetary matters, such an approach had merit. But it reversed past and present Air Force practice. Instead of starting with a budget and working backward, the Air Staff identified the number and type of airplanes required to fulfill a strategic concept. Collbohm noted that this approach led readily to budgets "built on the numbers racket." Counting planes resulted in a planning process in which the Air Force tended to "make your budget as big as you can."[75] The request for high performance aircraft only exacerbated the dynamic toward higher budgets.

While this insight may have caught the attention of some on the Air Staff, it was anathema to LeMay and SAC--which is why Collbohm was so eager to have the commander at the July meeting and why, immediately after his conferences with Everest he headed to SAC headquarters in Omaha. LeMay was absent but his deputy Thomas Powers listened to the Paxson presentation and was apparently unmoved. Powers, according to Collbohm, acted as "though we were a bunch of Congressman and he was defending the Air Force. He was personally guaranteeing they would be able to hit the targets."[76] Collbohm and RAND, obviously, had not

75. Ibid, p. 7.

76. Ibid, p. 8.

established with SAC the family rapport they sought through their briefings in Washington and Omaha.[77]

Collbohm kept Rowan Gaither, chair of RAND's Board of Trustees, apprised of developments with Paxson's study, RAND's funding situation, and of the rivalries and conflicts in the Air Force. In advance of a trustees meeting in mid September, Collbohm, Gaither, and J.R. Goldstein, RAND's associate director and a long-time colleague of Collbohm's from Douglas Aircraft, met to assess RAND's objectives as a corporation. The events of the past months had created some doubt whether the concept of military worth and the practice of systems analysis were the right organizing principles for the corporation. Could RAND provide the tools for understanding and coordinating the sprawling military enterprise? Gaither offered Collbohm and Goldstein encouragement that RAND was charting the right path. In a long disquisition he offered his view of RAND's animating spirit, a sophisticated update on the thinking of Williams and Weaver in 1947. Gaither ventured:

> The military now is confronted with problems of the greatest complexity. They are no longer problems of simply hardware or training of personnel but they actually embrace all fields of knowledge, and the need to acquire this knowledge and assimilate it into the Military Establishment is greater in this period of our history than any other period.... It has got to make use of the new fields of science from the most basic to the applied...all the disciplinary skills in analyzing the problem, in determining the knowledge that is necessary in the solution of the problem, and then applying it.[78]

77. LeMay, though, apparently did not want differences over the selection of a strategic bomber to undermine their broader working relationship. In August he met with Paxson to suggest a "closer working liaison between his headquarters and RAND...and suggested joint meetings between our two organizations at irregular intervals (say--six weeks)." Memo from E. Paxson to F. Collbohm, 23 August 1949, Folder "Incoming Memos, July-Sept 1949," F.R. Collbohm Papers, RAND.

78. "Transcript of Conference--H. Rowan Gaither, F.R. Collbohm, J.R. Goldstein," 1 September 1949, pp. 1-2, Folder "Dictaphone Transcriptions, 1949," F.R. Collbohm Papers, RAND.

The National Military Establishment, Gaither continued, needs "some mechanism, some instrumentalities" to rapidly assimilate and integrate this knowledge into military affairs, and then encourage research leading to more knowledge. RAND was such a device. To make this effective, the military also needed to overcome the pluralistic character of American political and institutional life, "to bring these groups which are splintered and fragmented together so that they will work as a group...RAND was set up around that principle and [it is] one of the important principles which may constitute the whole RAND concept and philosophy."[79]

The prospect of a protracted struggle with the Soviets, anticipated by many observers in and out of the military, only accentuated these needs. "The period which we are now in," Gaither reflected, "is one of international tension which is going to require a large military establishment, not only for a few years, but in the minds of many people, perhaps a generation or longer....The military structure...is going to be a permanent continuing expense that has to be imposed on our economy in a most intelligent way, utilizing the skills of civilian scientists."[80] Gaither recognized that management of the economy was perhaps a task better entrusted to civilians than the military, but the distinction seemed of little relevance given his earlier thoughts. RAND, though, could be a mechanism toward this end as well. "RAND," Gaither stated, "is well equipped because of its knowledge of industry, its knowledge of economics and the functions of our economic systems, to aid the

79. Ibid, p. 3.

80. Ibid, p. 4.

military in more intelligently imposing these things under it."[81]

Gaither's thoughts were reminiscent of Progressive notions of continuous management. RAND, in his view, was bound to the military, but also was an elite voice for reason, efficiency, and responsible stewardship of the nation's institutions and resources. Gaither viewed with alarm the threat to "a good many of our democratic principles" created by loyalty oaths, FBI investigations, and Joseph McCarthy's accusations on the presence of communists in government agencies--events that had grown in intensity over the spring and summer of 1949. He believed military readiness was achieved by strengthening existing political institutions through the calm rationality of efforts like RAND. RAND had an opportunity to contribute to the public good because "it is working with one of the largest departments of government and certainly the one that has got the greatest control over much of our functions, simply because of its dollar control, dollar expenditures, and because it is in a position to be very vocal on things which affect educational institutions and everything else."[82] Any concerns that Gaither possessed on the greatly enhanced ability of the military to shape national life were tempered by his belief that rational planning, provided by organizations such as RAND, would preserve the integrity of traditional institutions.

Gaither's thoughts had a practical turn. Collbohm and others had certainly foundered in conveying RAND's distinctive cast to Air Force leadership. Gaither

81. Ibid.

82. Ibid, p. 6.

and Collbohm now, and Weaver and Williams earlier, saw RAND as distinct--not an academic institution nor a military adjunct for operations research like the Navy's Operations Evaluation Group (OEG). The challenge was to convey this unique image of the organization to others, particularly Air Force leadership. Goldstein noted ruefully that the Senior Officers Board did not "really know what the hell we are doing or what we are or what we can do, and that we get lost, I think, along with the thousand other research establishments."[83]

The best way to correct this deficiency was to complete the Paxson study and report it to the Air Force. At the meeting of the Board of Trustees a couple of weeks later Paxson presented his study-in-progress. According to the RAND newsletter, Gaither sent the meeting's "performers a long congratulatory message decked with verbal posies."[84] Gaither felt, perhaps, that Paxson's study fulfilled the characterization of RAND that he had articulated for Collbohm and Goldstein. More importantly, the trustees strongly emphasized that "it should be RAND's policy to concentrate all effort on the fulfillment of the aims and purposes which the Air Force had been supporting for three years and to complete the kind of analysis which had been promised to the Air Force."

Over the fall Paxson pushed to complete the study and to share the work-in-progress with the WSEG and with SAC. WSEG had finally begun to research in earnest the question that Forrestal asked in fall 1948: Could the strategic air

83. Ibid, p. 8.

84. *The RANDom News*, Vol II, no. 20, 7 October 1949, p. 1.

campaign as contained in JCS war plans actually be executed successfully? Both studies surely took on added urgency after United States experts confirmed in mid September that the Soviets had detonated their first atomic bomb in late August. The WSEG charge differed from the problem Paxson was trying to answer. The WSEG was looking at current capabilities--whether B-29s, B-50s, and B-36s could execute the plan; Paxson was looking at future conditions. But both drew on a similar base of data on the nature of the attack, aircraft performances, the likely strength of Soviet air defenses, bombing accuracy, and prospective targets. And both aimed to complete their studies in January 1950. It seems that both groups worked to ensure that their methods and conclusions were not at odds. RAND had been studying the general problem for almost three years; WSEG for a couple of months. Over the summer and fall the two organizations established close working relations, undoubtedly with encouragement from the Air Staff. RAND first assigned Ernest Plesset, Chief, Nuclear Energy Division, as liaison to WSEG and then James Lipp, Chief, Missiles Division. Two other RAND staff also were detailed. At RAND Gene Root, Chief, Aircraft Division, organized several studies in support of the WSEG effort. RAND and WSEG also collaborated in experiments to assess the persistent question of how United States bombers would fare against Soviet fighters. Both the Navy and Air Force staged interception tests between B-36 bombers and United States fighters, with results used as data for programming simulated duels on computers.[85]

85. Memo from L.J. Henderson to H. Speier, 22 July 1949, Folder, "Incoming Memos, July-Sept 1949," F.R. Collbohm Papers, RAND; memo from S. Jeffries to W. Niles, 1 November 1949, Folder "Incoming Memos, Oct-Dec 1949," J. Goldstein Papers, RAND; memo from J. Wylie to L.E. Root, 20 November 1949, Folder "Incoming Memos, Oct-Dec, 1949," F.R. Collbohm Papers, RAND. On the tests see "Excerpt from the Washington Post," 16 November 1949, Folder "Incoming Memos, Oct-Dec, 1949," F.R. Collbohm Papers, RAND.

Collbohm and Paxson also continued to try to win LeMay's confidence. Collbohm presented the systems analysis to LeMay and his officers again in early November, this time apparently with slightly more success than in July. According to Collbohm, LeMay initially responded to the briefing with prickly antagonism. But in wrap-up discussions, LeMay's position on the RAND study, which could conflict with his own views on SAC, seemed to soften. As reported by Collbohm, LeMay conceded that there was potential merit in RAND's position that more, low-performance bombers might be more effective than a few high-performance aircraft:

> I have changed my mind a little bit on some things. I used to think, right up to now, that as guided missiles--air-to-air and ground-to-air--were put into operations, we would have to have airplanes that would go faster and faster and bigger and bigger. Now I am beginning to see that maybe we would be better off with just ninety mile an hour boxcars but a hell of a lot of them all carrying RCM [radar counter measures].[86]

While LeMay may have seen some validity in the RAND argument, the issue still remained to be settled in the months ahead.

<u>The Strategic Bombing Systems Analysis, 1950</u>

Paxson finished a complete draft of the top secret study, now called the Strategic Bombing System Analysis, in early January 1950. RAND promptly briefed Chief of Staff Hoyt Vandenberg and about twenty other Air Staff officers on 9 January. Vandenberg quickly appointed a technical advisory committee from

86. Transcription, "Partial Recording of Conference," 17 November 1949, p. 1, Folder "Dictaphone Transcriptions, 1949," F.R. Collbohm Papers, RAND.

the Air Staff to review the study, its assumptions, its methodology, and the implications of the recommendations. RAND presented the study to this group within a few days. LeMay was present on 9 January and asked for a separate presentation to SAC staff later in the month. The WSEG leadership and technical staff was briefed on the study next, soon followed by a group of over two hundred representatives of the Air Force, Navy, Army, Department of Defense, AEC, Bureau of the Budget, and other government officials. Next was a briefing on January 24 to those involved in atomic weapons development--Sandia Corporation, the Armed Forces Special Weapons Project, Los Alamos laboratory, the AEC's Military Applications Division, and others. On January 27 the Air Forces AMC staff heard the story in Dayton. On the 30th Paxson delivered a briefing to SAC staff in Omaha, as LeMay had requested.[87] The study was also issued as a report for circulation in the Air Force and other agencies.[88]

This grueling round of briefings reflected the high level of interest in the questions Paxson addressed in the systems analysis and the degree to which it intersected with questions of budgets, procurement, and rivalries within the Air Force and with other services. This was the opportunity Collbohm, Gaither, and Paxson

87. RAND and the Air Force carefully considered the sequence of briefings and the attendance lists as early as November 1949. See memo from L.J. Henderson, Jr., to F.R. Collbohm, 30 November 1949, Folder "Memos, 1949," L.J. Henderson Papers, RAND.

88. *Strategic Bombing Systems Analysis*, 1950, RAND Publication R-173. This report is still classified "secret-restricted data." The contents of the report, though, have been gleaned from RAND's periodic progress reports to the Air Staff, RAND's internal newsletter, Collbohm's dictaphone transcriptions of meetings, and Air Force records on evaluation of the study.

had been anticipating. The study and the associated briefings would demonstrate the validity of RAND's program to make air warfare a science, providing an exemplar on the rational use of military and social resources in an age of total war--and, as an added benefit, secure RAND's own corporate future.

The study argued for two principal recommendations. The first was a "best" airplane for the strategic mission: a turboprop bomber with a gross weight of 170,000 pounds, 400 knots average cruising speed, and average altitude of 47,500 feet. The B-52, in comparison, used turbojets, could reach slightly higher altitudes, and cruise at 450 knots, but weighed nearly twice as much to achieve these extra margins of performance--and hence would cost substantially more. The RAND plane also had a predicted range greater than the B-52, at approximately 4370 nautical miles--a range that permitted attack on 85 percent of Soviet targets with flights initiated from North America without refueling. The study also recommended a specific size of atomic bomb to maximize target destruction: 8,000 lbs.[89]

Paxson revealed that a crucial factor in overcoming Soviet defenses was the number of aircraft deployed. Based on his analysis, Paxson offered that the most destructive mode of attack was to "saturate" Soviet defenses in the major target areas simultaneously. Aircraft traveling in groups of ten could minimize the losses caused by air defenses and maximize damage to targets. The formulation and solu-

89. These major recommendations are outlined in a memo from Col. Potter to S. Symington, 27 March 1950, Folder "095 RAND Corp.," Entry 1, RG 340, NARA.

tion of this problem exemplified the potential of game theory in solving military problems. This result was important. Paxson earlier had the insight that in accomplishing the strategic mission a condition of lean budgets favored a planning strategy based on procuring a greater number of less sophisticated, less expensive aircraft--instead of buying fewer aircraft of higher performance and greater cost. The analysis of how best to attack Soviet air defenses only reinforced the argument for "numbers over performance" resulting from limited budgets.

As RAND well knew, this was not a conclusion that inspired LeMay, who would have to use the RAND-recommended airplane if service leadership was persuaded by Paxson's work. Collbohm, in reporting on the series of January pre sentations to the RAND Board of Trustees, noted that LeMay's response was:

> ...the tough, practical reaction of the man who will have to fly the airplane. In general, his attitude was one of intuitive disbelief that an airplane of this type could be superior to something higher and bigger and faster. There was the clear intuitive preference of the operating officer for an airplane just as big and high and fast as he can get.[90]

At a meeting in February the RAND Board of Trustees explored some of the ramifications of presenting recommendations that were strongly resisted by LeMay

90. F.R. Collbohm, "Memorandum for the Trustees," 8 June 1950, p. 2, Folder "Oral History Working File--Lawrence Henderson," RAND Oral History Project, NASM. LeMay and other military officers had two concerns in this regard. One was that, compared to the B-52, the RAND airplane inevitably would result in higher casualties, which might well affect crew morale. Based on the experience of World War II, morale was considered a crucial factor in executing successful missions. The other was that the greater number of airplanes called for by the RAND scenario would require a significant increase in the number of crews. LeMay had already experienced difficulties in training crews to meet the demands of long-distance air attack as called for in SAC and JCS war plans.

and other service officials, raising again the question of how RAND research was interconnected with service politics.[91]

Paxson's briefings generated two responses. The Senior Officers Board viewed the study with cautious optimism. To managers responsible for planning the Air Force's program of research, development, procurement, and strategy Paxson's results and methodology seemed a means to order an unruly environment. The challenges of technology and politics had been bedeviling service leadership since the war. Paxson's study could clarify choices and draw together disparate interests within and outside the service. The response of LeMay and the AMC was quite different. The study was something to be questioned, its authority dismantled.

From February to April 1950 the Senior Officers Board and RAND skillfully moved to use the study as an instrument for organizing disparate groups into a consensus on planning for the strategic mission. The board itself promoted the various briefings RAND made on the study and, perhaps more important, managed the forums of dissent. In addition to initiating the technical review by the Air Staff in January, the board asked the Air University, the AMC, and SAC to submit their criticisms in writing and present them before the board.

91. See "Transcript of Business Sessions of Board of Trustees Meeting," 10 February 1950, Folder "Dictaphone Transcriptions, 1950," F. Collbohm Papers, RAND. Trustee Charles Dollard noted: "I think we have two factors to consider...one is what is our own judgement about what might pay off and what is the political context, so to speak, in which you must work--it's a balancing of those factors. I think we ought to be conscious of these two points. I am not sure the Air Force is always the best judge." Collbohm replied: "The Air Force does not tell us what to do." Dollard rejoined: "No, but they imply." On p. 17.

RAND, in turn, aware of the study's many shortcomings, responded to criticisms as quickly as possible. One of the most obvious flaws--due to the press of time and the difficulty of calculations--was that the analysis presented in early January covered only a first strike in an attack on the Soviet Union. Subsequent attacks, as called for in existing JCS war plans, were not examined. LeMay and others felt this might well alter the study's conclusion on the best aircraft. Paxson rapidly proceeded to get at least preliminary answers, some of which were ready by late January when he went to SAC. AMC, too, criticized the study from its special perspective, claiming the study did not use the most current data on aircraft designs, engines, and electronic gear.[92] Another flaw was that Paxson did not update the study to include the implications of an important development in weapons technology--hydrogen bombs--in his analysis. RAND, through Ernest Plesset and its Nuclear Energy Division, was aware of the recent decision to proceed with building such weapons as well as their predicted effects.[93] Paxson made an effort to incorporate this change into his study as well.

As Paxson continued to refine the study, he and Collbohm made frequent trips to Air Force headquarters to brief individuals who had not heard the talks in

92. See memo from L.E. Root to F. Collbohm, 16 March 1950, Folder "Incoming Memos, Jan-March 1950," J.R. Goldstein Papers, RAND.

93. In 1948 the Air Force had asked RAND to study the interrelation between bomb sizes and aircraft designs; in January 1950 the service pushed RAND to expand this work to include analysis of weapons effects--undoubtedly motivated by the possibilities of the H-bomb. See letter from F. Collbohm to Gen. Putt, 27 January 1950, Folder "Incoming Memos, Jan-Mar 1950," J.R. Goldstein Papers, RAND; and memo from E. Plesset to F. Collbohm, 27 January 1950, ibid.

January, such as Secretary Symington, or those who wanted to hear it again.[94] Collbohm and Lawrence Henderson, head of RAND's Washington office, made a special effort to alert Symington to the importance of the study. Henderson, in concert with one of Symington's aides, prepared a synopsis for the Secretary's consideration, highlighting the twin advantages of the RAND airplane--its suitability for attacking Soviet targets and its low cost compared to the B-52. The summary noted that:

> What they [RAND] do recommend is that we consider the proposition that in fact we would but more national security with smaller, cheaper airplanes than by trying to push speed performance as far as possible, with the resulting inordinate cost. The corollary advantages of a relatively small, simple airplane are very attractive. With the size, takeoff, and performance characteristics of the airplane RAND is recommending, our base and operating problems would be vastly simplified, and it is more likely that there would be important commercial applications of such an airplane...[95]

Symington retired as Secretary in April (succeeded by his Undersecretary Arthur Barrows) and did not seem to take any position on the RAND recommendation. But clearly Henderson sought to elicit Symington's support by connecting RAND's work to Truman's budget restraints and the Secretary's concern for the health of the aircraft industry.

In mid April the Senior Officers Board returned to the complex of issues surrounding the RAND study, but expanding their deliberations to include planning on a research, development, and procurement program for the period 1950-1960.

94. See Dictaphone Transcript, "Report of Trip by F.R. Collbohm," 28 March 1950, Folder "Dictaphone Transcriptions, 1950," F.R. Collbohm Papers, RAND.

95. Memo from Col. Potter to S. Symington, 27 March 1950, note 89.

This was their most ambitious attempt since the end of the war to map a long-range program for the Air Force. The strategic bomber program was a large part of that, as demonstrated by the protracted discussions on the B-52 over the last two years. RAND's study promised to help directly address that issue. But the methodology of study--the ability to weigh and interrelate so many variables pertaining to technology, strategy, operations, and budgets--also seemed an instrument to sort out the broader problem the board members needed to consider.[96]

Idwal Edwards, acting Deputy Chief of Staff, Operations, chaired the board for these meetings, which were held over five days. He carefully orchestrated the proceedings to try to build a consensus around the RAND study--not as an advocate for the study's recommendations but of its methods. Edwards used the RAND study as a focus. It was the tool to bring the different factions--LeMay and the AMC as antagonists, the board as cautious supporter--to a common ground. The RAND participants were a kind of Greek chorus for the methods and results of the study. Edwards asked Paxson to present the study before the board, even though

96. RAND's standing with the board received a boost at this time from the service's Scientific Advisory Board (SAB). In 1949 Air Force leadership requested the SAB to assess RAND's work and contributions. The SAB appointed a special "Project RAND Committee" to look into these issues. This review apparently arose out of the same confusions evident in the Senior Officers Board discussions on RAND in early 1949. The SAB strongly endorsed RAND's development of systems analysis and the composition of the RAND research staff (especially the integration of the hard and the soft sciences in the corporation) in support of this work. See, for example, memo from J. Allen to J.R. Goldstein, 24 April 1950, "Report of RAND Committee of the SAB," Folder "Incoming Memos, April-May 1950," J.R. Goldstein Papers, RAND. On the work of the SAB RAND committee see memo from R. Gibson to Members of the Project RAND Committee, 9 November 1949, Folder "334.5 Scientific Advisory Board (1951)," Series 10, RG 341, NARA; and memo from R. Gibson to File, 21 December 1949, Folder "095.1 RAND Corporation (1951)," Series 10, RG 341, NARA.

nearly everyone had it heard at least once before. SAC and AMC then presented their critiques, which primarily revolved around the same response LeMay had in January: the study went against the grain of years of Air Force experience which argued for procuring higher performance aircraft. RAND was asked to repeat some parts of the briefing.[97]

Edwards, at RAND's suggestion, also invited the heads of most of the major aircraft companies to come join the meetings.[98] He wanted Paxson to deliver the briefing to them, which he did. Edwards's motive was to share with industry the approach to planning that the Air Force might be taking. But the invitation was also to alert the companies to the possibility of a shift in research and development practices--that perhaps in the area of bombers the push for high performance aircraft might slacken. The companies then, too, would have to change their expectations and approach to research and development. Edwards asked the companies to review the RAND study and offer comments to the board at the beginning of June.[99]

97. On the board's approach to the meetings see Proceedings, USAF Meeting Senior Officers Board, 17-18 April 1950, Box 7, Entry 450, RG 341, NARA.

98. See teletype from J. Goldstein to F. Collbohm, 14 March 1950, Folder "Outgoing Memos, Jan-June 1950," J.R. Goldstein Papers, RAND.

99. RAND welcomed the inclusion of the aircraft industry as part of the process of consensus building associated with Paxson's study, but these discussions revealed the corporation's shaky status as a disinterested voice of science. The Air Force had been using RAND to evaluate industry design proposals for bombers and, thus, placing RAND in the middle of the contentious politics of procurement. Moreover, at this stage, the Douglas Company submitted a proposal to compete with the B-52 and RAND airplanes. The Air Force called on RAND to assess this entry as well. Douglas expected RAND to provide a supportive evaluation of their proposal. See, for example, memo from Jean Wylie to J.R. Goldstein, 14 March 1950, Folder "Incoming Memos, Jan-Mar 1950," J.R. Goldstein Papers, RAND.

The April meetings, though, placed RAND in an awkward position. For the board, systems analysis seem to offer the possibility of illuminating the hard choices confronting them on research, development, and procurement. But in the process RAND itself was drawn into the board's sense of urgency to decide on specific programs such as the B-52 and on a ten-year plan. As Collbohm later noted to the RAND Board of Trustees, "obviously we have stimulated a certain amount of appetite, or demand, for scientific analysis."[100] It was one thing, though, for the bombing systems analysis briefings and report to serve as an instrument to organize decision making within the Air Staff and commands and with industry. This was RAND's goal as outlined by Gaither some months before. But RAND (perhaps naively) failed to appreciate that once the briefings and report were presented, the corporation would inevitably be drawn into building a political consensus for such decisions with the board.[101] RAND could not maintain a clear boundary between its proclained role as a voice of science and its role as a contributor to a process of policy and decision making in which it advocated the merit and vailidity of its research. As Williams and Weaver had noted earlier, research needed to be communicated, explained, and argued for if rational assessment were to replace intuition and experience in preparing for modern war.

100. See memo from F. Collbohm to RAND Board of Trustees, 8 June 1950, p. 16, L. Henderson Papers, RAND.

101. Collbohm expressed concern that the board's proceedings, detailing the Air Force's deliberations on an important procurement such as the B-52, might be reviewed by Congress. If this were to happen, Collbohm thought, it would not look good for either RAND or the Air Force, if the corporation played too prominent a role in such crucial areas of decision making. See memorandum F. Collbohm to RAND Board of Trustees, 8 June 1950, note 94, p. 14.

Edwards asked RAND to provide a response not only to the SAC and AMC criticisms of the RAND study, but also to those commands' contributions to the board's initial attempts at a ten-year plan for research, development, and production. Edwards even hoped RAND would direct the review of AMC and SAC in front of the board. Collbohm mulled the request over and decided against it. RAND, he thought, would lose all credibility if it reviewed and commented on these long-range plans without any preparation or analysis. The Paxson study covered only strategic bombing, and it took nearly three years to complete. RAND could not possibly make quick judgments on the much larger question of a ten-year plan for the whole Air Force. As Collbohm recounted these events a few days later back in Santa Monica:

> General Edwards has asked us to comment on the whole show and run it the second time. It has been helpful to us to hear it. We think it was worthwhile to help us in future analyses. But I didn't think it was safe for us to make comments for the reason that we didn't think it should go on the record that an organization set up to provide unbiased, completely objective analytic work should go on the record with simply intuitive comments that might reflect seriously in the future both against RAND and against the Air Force.[102]

Collbohm's sense was that "quite a number of people were very unhappy" about his position. Edwards, Collbohm offered, did not want to take no for an answer: "Edwards started again to put us on the spot." Edwards suggested that RAND take a few weeks "to examine the whole problem of the Air Force, do some analytic work, and come back with recommendations as to what the Air

102. Dictaphone transcript, "F.R. Collbohm's Report to Staff on Washington Trip," 26 April 1950, p. 10, Folder "Dictaphone Transcriptions, 1950," F.R. Collbohm Papers, RAND.

Force should do in this major policy planning for the period 1955 to 1960."[103] Collbohm resisted this too. Another board member suggested that they appoint a small group to work with RAND and investigate the problem jointly. Collbohm rejected this overture for the same reasons he stated earlier. Collbohm noted that "kind of left the thing hanging up in mid air because in effect it says that we wouldn't even do that. Then we were kicked out and they went into executive session."[104]

Collbohm's resistance helped the board determine that their sense of urgency to establish a ten-year plan and make a decision on the RAND aircraft versus the B-52 could be delayed at least for some months. The hope was that RAND would continue to look at both the narrower and broader questions that had arisen at the April meetings and contribute to the board's deliberations in late fall 1950.

Between April and June RAND stepped up its attempt to broaden the Paxson study to include successive air attacks to simulate more closely an air campaign as stipulated in SAC and JCS war plans. But the new complexities were not easily addressed and no quick, definitive answers were forthcoming.[105] At the same time,

103. Ibid.

104. Ibid, p. 11.

105. On this expansion of the Paxson endeavor, called the Dynamic Bombing System, see the series of working memoranda of the study group in Box 5, Brownlee Haydon Papers, RAND. The study group began work in February with hopes of completing a preliminary design for a multiple-strike campaign by May. By fall 1950 the project had made some progress but work continued into spring 1951. By that point any recommendations were moot; the decision in favor of the B-52 had already been made. See *Project RAND Staff Report*, 1 March 1951, RAND Publication R-214. The report describes several studies that were completed as part of project over the previous six months.

reviews of the original RAND study requested by the Senior Officers Board were coming in. One set of reviews came from the industry representatives invited to the April meetings. These reviews were generally favorable, but differed occasionally with RAND's assumptions on likely developments in engine, structures, or other aircraft technologies.[106] A more critical review came from the Air University, an internal service group for assessing policy, doctrine, and organization. General George Kenney, head of the Air University and the predecessor of LeMay as head of SAC, forwarded his organization's critique to Chief of Staff Vandenberg in early June. Not surprisingly the primary failing was the one advanced by LeMay; Kenney noted that: "our most important conclusion is that the airplanes recommended by RAND are purely 'budget' airplanes and represent dangerous compromises of quality to obtain quantity."[107]

The Senior Officers Board met just before receiving the formal responses of the aircraft industry and the Air University to Paxson's strategic bombing systems analysis. Edwards and other members of the Senior Officers Board still regarded the RAND analysis as a potentially powerful instrument for planning and organizing resources within and external to the service, despite the SAC, AMC, and Air University concerns. But in their June meeting the board made no further effort to resolve the tension between the perceived requirements of planning under

106. These reviews are contained in Folder "Industry Comments on R-186," Box 5, Brownlee Haydon Papers, RAND.

107. Letter from G. Kenney to H. Vandenberg, 9 June 1950, unfoldered, Box 14, Brownlee Haydon Papers, RAND.

Truman's budget constraints and the strong views of LeMay and others.[108] Not until September, after the start of the Korean War, did the board return to the contending views over the Paxson study.[109] By that point, SAC, AMC, and, to a lesser degree, the aircraft industry had poked holes, small and large, in the systems analysis, seeking to undermine its major recommendations as a way to advance their own interests. Their tactics were analogous to traditional patterns of scientific critique: question the organizing assumptions, question the data, question the methods. It was a rejoinder to which Paxson's work was particularly vulnerable due to the sheer complexity of the task, the changing state of technology, and the limitations he placed on his work to arrive at any answers at all.

The presentation of and response to the Strategic Bombing Systems Analysis highlighted the odd status of RAND's attempt to make a science of air warfare. The goal of this enterprise, as Gaither argued in September 1949, was "to bring these groups which are splintered and fragmented together so that they will work as a group...RAND was set up around that principle and [it is] one of the important principles which may constitute the whole RAND concept and philosophy."[110] And in a fashion RAND's first systems analysis accomplished this. But it also demonstrated the ways in which their undertaking differed from the traditional conceptions of science that RAND staff invoked to legitimate their work.

108. Transcript, Senior Officers Board, 2 June 1950, Box 8, Entry 450, RG 341, NARA.

109. On these discussions see Transcript, Senior Officers Board, 18-19 September 1950, Box 9, Entry 450, RG 341, NARA.

110. See note 78.

RAND did not communicate their results to a group of scientific peers but to audiences--primarily the Air Staff and other elements of the service--who were, in part, the objects of research and had a vested interest in how the field was defined and studied. The service defined the bounds of RAND's research domain by posing specific problems for research. And the range and nature of those problems were limited by the Air Force's mission and political mandate as a part of larger governmental structure--a condition Williams had noted in 1946 as he pondered the implications of RAND's charge to research only "intercontinental warfare other than surface." RAND could not independently define the subject of air warfare, its organizing assumptions and methods. It had to do so in concert with Air Force. RAND could and did recast such limitations to fit with its aspirations for systems analysis but Air Force interests and expectations were an inseparable component of the enterprise. The various groups within the service, moreover, were both objects of research and experts on their own work. They could claim, as SAC and AMC did, that they possessed more specialized knowledge of the subject and thus could speak more authoritatively than RAND's air-warfare scientists. This back and forth on the proper content and methods of air warfare as science took place in a unique context. The Strategic Bombing Systems Analysis report and all the discussions in 1950 were security classified. This limited the audiences who could participate in the analysis's assessment, reinforcing service control over the interpretation and use of the report.

By the time the Senior Officers Board met in September the debate surrounding the Strategic Bombing Systems Analysis was moot. The postponement of the board's deliberations over bomber procurement, future research and development programs, and the RAND report proved to be a turning point in RAND's and the Senior Officers Board's ambitious conceptions of the possibilities of systems analysis. The start of the Korean War in June 1950 increased military budgets dramatically. Before the war the total military budget was just over $13 billion dollars; by the end of 1950 it was over $48 billion. The next several years saw further increases.[111] Before the war Truman had sustained a climate of restraint; after the start of war military expectations soared.

The major recommendation of Paxson's study had been, by military standards, a slow, unexciting aircraft, designed in response to the exigencies of budget constraints. By fall 1950 the Air Staff was ready to purchase the B-52, the high-performance plane that LeMay and AMC had supported, as the next strategic bomber of the Air Force. The budgetary limitations that favored a RAND-type airplane, at least in a systems analysis, no longer held. The climate of economy also had provided the stimulus for Gaither's concept of carefully husbanding and planning the military's and the nation's resources to meet the demands of total war. Awash in wartime funds neither RAND nor the Air Force saw the need for the large-scale coordination of social resources implied by the Strategic Bombing Systems Analysis. Both continued to advocate planning based on a systems analysis-style of science, but the grand objectives espoused by Weaver and Wil-

111. On increased military budgets associated with the Korean War see Doris Condit, *History of the Office of the Secretary of Defense,* Volume II: *The Test of War, 1950-1953* (Washington, D.C.: Historical Office, Office of the Secretary of Defense, 1988.)

liams, and evident in Paxson's work, receded into the background. A policy of increased armament and funding would be the lubricant to dampen rivalries within the Air Force and among the services and to organize the contributions of industry and universities in preparing the nation for modern war.

While the Korean War undermined the concept of systems analysis envisioned by Gaither, Williams, and Weaver, Paxson's bombing study was still a defining undertaking for RAND. The supportive and sometimes eager reactions of the Senior Officers Board validated the idea that air warfare could be viewed as a science (as a domain amenable to investigation with the methods of the physical and social sciences and mathematics) and that such research could have practical value. Even the most vocal critics of the RAND study--SAC, AMC, and the Air University--accepted systems analysis as a valid tool for studying air warfare. Indeed, the study helped make the idea of military technologies and activities as systems a commonplace assumption of Air Force leadership.[112] The Paxson study, too, despite the rejection of the RAND-recommended airplane, certified systems analysis as RAND's distinctive corporate product--a product which justified the Air Force's contract with the new corporation. This was in part due to the promise of the analytic methods and the insight they might provide into crucial problems of organizing and fighting for war. But it was also due to the political value of the study to Air Force leadership. The Paxson study stood as an analytic counterbalance to the studies on the strategic air mission underway by the JCS and Secre-

112. On both these points see, for example, the discussions among the Senior Officers Board, SAC, and AMC at the September board meeting, note 109.

tary of Defense. As special study groups and the WSEG provided analytic expertise to the JCS and other parts of the government, the Air Force saw the value in having their own experts at hand. Although not foreseen in advance, Paxson's work served this end very effectively.

Within RAND, the Paxson study had several effects. One was to invigorate and focus RAND's own internal planning of its research program. Even before the presentation of Paxson's study in the first months of 1950, a planning group led by John Williams and including economist Charles Hitch, Paxson, and others, developed an outline of the major questions and problems confronting the Air Force.[113] During 1950 this internal planning exercise became more formalized and regular. Williams and company identified a number of successor studies on the strategic bombing mission, some as broad in scope as Paxson's original work (for example, an examination of a campaign of successive air strikes against the Soviet Union mentioned above), as well as work on air defense, guided missiles, logistics, and other issues.[114] The goals of this mapping exercise were to ensure that RAND possessed a comprehensive view of its research domain and to identify studies more limited in scope than the Paxson project but which addressed practical

113. See, for example, memo from C.J. Hitch to Staff, "Outline--Systems Analyses of Air Warfare," 3 November 1949, Folder "Incoming Memos, Oct-Nov 1949," J. Goldstein Papers, RAND.

114. Paxson's work also stimulated an appreciation for developing plausible estimates of the costs of present and future technologies. In February 1950 RAND established a Cost Analysis Section in the Economics Division, under the leadership of David Novick, with the charge to "cost whole weapons systems for RAND Systems Analyses." See memo from C. Hitch to D. Novick, 1 March 1950, Folder "Incoming Memos, Jan-Mar 1950," J.R. Goldstein Papers, RAND.

problems of the Air Force. Defined in this way, such studies might be integrated into a larger framework of analysis at a later time. This refashioning was both to simplify analysis and to improve the possibility of gathering reliable data. Paxson's work, then, confirmed the general approach of systems analysis but stimulated a reappraisal of how RAND should define problems for research, redirecting the corporation's effort toward studies of more limited scope. In so doing future systems analyses focused more on internal management problems of the Air Force and less on issues that touched on the service's relations with industry and other groups.

Among Williams's research planning group the Air Force response to Paxson's work also raised cautions on defining the organizing assumptions for a systems analysis. Paxson's assumption specifying limited budgets and his decision to drop consideration of intermediate bases from his analysis had profound effects on the conclusions of his work. Hitch and others in RAND's economics department began an intensive consideration of how to frame rigorously the criteria defining a study. Their review led to a change in approach for presenting RAND's next major study, the Air Defense Systems Analyis. In preparation since 1947, this study was finally taking shape in mid 1950. RAND management wanted to be sure that the corporation and the Air Staff both supported the assumptions of the analysis before its completion. Collbohm and Henderson arranged a briefing in July 1950 dedicated to a collaborative review of the study's organizing assumptions, in an attempt to preclude the kinds of criticisms that had greeted Paxson's work.[115] In the end, RAND would need not just a research method that appealed to the Air Force, but also would have to generate conclusions and recommendations derived from assumptions that the service regarded as valid. Specifying defensible working assumptions for a systems analysis would be one crucial aspect in solidifying the credibility of RAND's research. RAND's caution on this point reflected the intricate ways in which the Air Force was both a participant in and the object of RAND's effort to make air warfare a science.

The Paxson study and the reactions to it set the tone for systems analysis at RAND through the 1950s. As a practical matter, studies aimed at more limited, manageable problems than Paxson's ambitious treatment of the strategic air campaign. This dimunition in the reach of systems analysis fit well with the changed funding and planning environment brought on by the Korean War.

115. See memo from L. Henderson to F. Collbohm, 10 July 1950, "Washington Briefings," Folder "Memos, 1950," L. Henderson Papers, RAND.

Conclusion

A constant refrain through RAND's first years was that technology and total war had erased the boundaries between the civilian and the military, between war and peace. Implicit in this change was the perception that new efforts and mechanisms were needed to coordinate the efforts of those most involved with the challenges of modern war--the military services, industry, and academia. The ideology of preparedness widely expounded by Arnold and others only emphasized the urgency of the task. But wartime planning for the postwar period provided no set prescription for the manner in which the institutions that had worked together during hostilities would interact in the years to follow. Wartime models such as the Office of Scientific Research and Development (OSRD) and the Manhattan Engineer District were important, as was policy elaborated by the President and Congress. But the military services, in conjunction with academics and industrialists, were social innovators of equal import.

The RAND case suggests the subtle and inventive ways the relations among the military, industry, and academia were constituted, as different interests, motivations, and organizing assumptions came into play. Edward Bowles's attempt, with Hap Arnold's encouragement, to establish RAND as an associationalist venture reveals a distinctive strand of postwar planning. Bowles's model for RAND and the Air Force argued for a preeminence of military interests in controlling the resources of science and technology. It stood in sharp contrast to the work of his antagonist and colleague, Vannevar Bush. Bush's efforts to establish a National Research Foundation (NRF) and the Research and Development Board (RDB) represented a strategy for containing military interests and protecting those of the university. Bowles and Bush saw their respective visions as competing, antithetical prescriptions for postwar organization.

Bowles's failure to sustain his associationalist experiment was due to his own limitations as a bureaucratic politician and as a consultant without authority over budgets or personnel. Equally germane were the rapidly shifting set of problems for industry and the Army Air Forces as demobilization set in and planning for unification into the National Military Establishment began. But this failure did not diminish the perception of those who led Project RAND that the purpose of the organization was to address the same challenge perceived by Bowles: drawing together the social resources necessary to prepare for modern war. The work of Warren Weaver and John Williams to make air warfare a subject of research served as an alternative strategy for reaching the same end and as an organizing principle for Project RAND in its transition to a nonprofit corporation. Indeed, Williams, Collbohm, and Gaither intended this research as RAND's distinctive product. Both conceptions of RAND, too, were engendered by expectations that federal appropriations for defense would be less than required by the exigencies of preparedness. For the RAND and Air Force principals central to this account these factors stimulated an interest in scientific planning and allocation of resources by a managerial elite.

The origin of systems analysis was inseparable from this context. Its creation was the confluence of several factors. Two were the ideas of Weaver and Williams and Rand management's need for a distinctive corporate product. Two others derived from the specific political circumstances of the late 1940s: the crucial problem of selecting a new long-range bomber and the pluralistic nature of decision making internal and external to the Air Force. Gaining consensus on decisions such as the selection of the next strategic bomber was a contentious and consuming process, involving the Senior Officers Board, the Strategic Air Command (SAC), the Air Materiel Command, the Secretary of the Air Force, and others inside the service as well as a host of actors outside: the Joint Chiefs of Staff, the Weapons System Evaluation Group, Congress, the Secretary of Defense, the President, and the aircraft industry. Absent strong administrative mechanisms that could impose a decision, other tools or means for encouraging consensus seemed attractive, at least to Air Force military leadership.[1] Systems analysis, with its patina of scientific legitimacy, was welcomed by the Senior Officers Board as a possible counter to the endless rough-and-tumble of military decision-making. Paxson's Strategic Bombing Systems Analysis seemed a tool uniquely suited for organizing the many parties with a stake in procuring the next strategic bomber

1. In the political science and sociological literature this feature of American politics fits into a model of statebuilding called "weak" and "strong" states. On the relation of this literature to studies of the postwar national security establishment see Aaron L. Friedberg, "Why Didn't the United States Become a Garrison State?," *International Security* 16 (1992):109-142. Friedberg notes (p. 110, n.3) that "strong states are defined as those that are most capable of acting autonomously, formulating and pursuing goals independently of and in, some cases, in opposition to, the preferences of societal interest groups. Weak states, on the other hand, are permeated by pressure groups."

toward a decision--either a RAND airplane or the B-52. As a scientific product, Paxson's study seemed a way to stand outside of politics and at the same time organize a political consensus. For the Senior Officers Board systems analysis briefly seemed a fortuitous instrument for dealing with an American bureaucratic and political culture that favored pluralism in decision making over centralized planning and coordination.[2]

This story touches on existing literatures in several ways. One long-standing historiographic issue is the role of military leadership in composing the relations among the services, industry, and universities. This question has been addressed most often by political science and sociology studies on the national security state and the military-industrial complex. One strand of these writings has argued that military leadership was a crucial actor, either alone or in conjunction with other elites, in actively creating and sustaining the policy and practices of national preparedness.[3] Yet, for the most part, these accounts do not closely examine the

2. A useful study of the role of quantification in politics and policy making, especially the role of government agencies in fostering such methods to ease interest group conflict in bureaucratic decision making, is Theodore M. Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton: Princeton University Press, 1995).

3. One of the clearest statements that military leadership, in conjunction with business and university elites, were deliberate architects of a national security state is John K. Galbraith, *The New Industrial State* (Boston: Houghton Mifflin, 1967); the classic account of the military and elites from industry and universities as collaborative planners is C. Wright Mills, *The Power Elite* (Oxford: Oxford University Press, 1959). See also H.L. Nieberg, *In the Name of Science* (Chicago: Quadrangle Books, 1966), chapter 10. Nieberg claims that "knitting together the [military-industrial] complex is an elite group of several thousand men, predominantly managers and brokers, who play a variety of interlocking roles--sitting on boards of directors, consulting for government agencies, serving on advisory committees, acting as managers on behalf of government in distributing and supervising subcontracts, moving between private corporations and temporary tours-of-duty (p. 190)." Nieberg also highlighted the importance of the contract as an instrument connecting public and private spheres, dubbing the set of relations

actions and planning efforts of such leadership.[4] The behavior of the Air Staff covered in this account suggest a more ambiguous role for Air Force professionals as deliberate builders of a new political economy in the first years after World War II.

Arnold and Bowles's reorganization of the Air Staff through the creation of Curtis LeMay's post as Deputy Chief of Staff, Research and Development, and the establishment of Project RAND was intended to enhance managerial control over science and technology. Both were a means to develop a cadre of managers, spanning the service and industry, attuned to integrating science and technology into the Army Air Forces. Bowles modeled such changes on the organizational practices of large technology-based corporations such as American Telephone and Telegraph and General Electric. He had become intimately familiar with these corporations before the war through his work at the Massachusetts Institute of Technology and during the war as consultant to Stimson and Arnold. Bowles knew that such corporations had already recast their organizations so that planning for innovation was

enabled by military money the "contract state." A more recent account that draws on both Galbraith and Mills is Gregory Hooks, *Forging the Military-Industrial Complex: World War II's Battle of the Potomac* (Urbana and Chicago: University of Illinois Press, 1991). Hooks's first chapter provides a very useful overview of the literature.

4. For example, in Hooks, *Forging the Military-Industrial Complex*, note 3, the military's role as a source of contracts entailed that leadership purposely acted to build up and elaborate a national security state. This perception of leadership, though, is not grounded in careful study of particular decision-making forums. See especially chapter 4.

inseparable from corporate strategy.[5] The institutional changes he and Arnold pushed immediately after World War II had the same intent. The central importance of science and technology in modern war required, in their view, the creation of a management class to control and coordinate these crucial activities--both to reform practices and organization within the service as well as to manage relations with academia and industry.

But the reforms Arnold and Bowles implemented and the ideology they employed to support these efforts did not achieve the desired result. Neither the Air Staff nor the RAND Advisory Council took up their call and developed the personnel or the practices to plan actively and comprehensively the place of science and technology in the Army Air Forces. The actions of LeMay as Deputy Chief of Staff, Research and Development, and later the work of the Aircraft and Weapons Board and Senior Officers Board reveal a reluctance to assume even the circumscribed control and planning authority that Bowles and Arnold had envisioned.

5. Bowles's notions in this respect were somewhat idealized but nonetheless captured the new ways science-based corporations were incorporating research into the fabric of corporate planning and market strategy. On these developments in the late nineteenth and early twentieth centuries see, for example Leonard Reich, *The Making of American Industrial Research: Science and Business at GE and bell, 1876-1926* (Cambridge: Cambridge University Press, 1985) and George Wise, *Willis R. Whitney, General Electric, and the Origins of U.S. Industrial Research* (New York: Columbia University Press, 1985). Bowles's thoughts can also be tied to an early innovation that accompanied the rise of large business concerns in the last half of the nineteenth century: the creation of a corporate management class. This new professional class aimed to control the more complex internal operations and markets of these organizations as well as their relations with external markets. On this see Alfred D. Chandler, *The Visible Hand: The Managerial Revolution in American Business* (Cambridge: Harvard University Press, 1977). Bowles saw his innovations in the same light.

This reveals, in part, the ways in which prewar understandings on government-market relations limited Air Force perceptions on acceptable means for directing industry and academia toward service interests. Still the halting efforts at active management of science and technology within and external to the service suggest the need for a closer examination of Air Force leadership and that of other services as crucial actors in composing the postwar national security landscape. Explanatory accounts that rely on the actions of an interlocking group of public and private elites and the development of a "contract state"--important as these factors were--do not seem to comprehend fully the history of the services.[6] Through the end of the Eisenhower administration the services were pivotal institutions in constituting a military-centered political economy. Like big business concerns in the late nineteenth and early twentieth centuries--the institutional models Bowles drew on in formulating his prescriptions for the postwar Air Force--the military services were at the center of a reordering of American political and economic life. The work of Alfred Chandler and Martin Sklar on the rise of large corporations suggests one approach for better understanding the services's role in shaping the postwar period.[7]

6. On these interpretive schemes see note 4. For insight into the interlocking working arrangements between scientists and the military see Daniel Kevles, "Cold War and Hot Physics: Science, Security, and the American State, 1945-56," *Historical Studies in the Physical and Biological Sciences* 20 (1990):239-264.

7. Chandler, *The Visible Hand*, note 5. Applying Chandler's account of the corporation to the postwar period is suggested in Michael A. Dennis, "A Change of State: The Political Cultures of Technical Practice at the MIT Instrumentation Laboratory and the Johns Hopkins University Applied Physics Laboratory, 1930-1945" (Ph.D. diss., Johns Hopkins University, 1990). Martin J. Sklar, *The Corporate Reconstruction of American Capitalism, 1890-1916: The Market, the Law, Politics* (New York: Cambridge University Press, 1988).

While differences between the military services and the corporation as described by Chandler are patent (especially the services' place within a larger bureaucratic and political structure), the points of similarity are instructive. Like earlier corporations, the services had to contend with a new set of relations among technology, knowledge, modes of production, and scale of operation. While mass production and the mass market were emblematic of the earlier transformation of political economy, the problem of weapons was the mark of the postwar period. This problem had two components. One was the perceived success of science- and technology-based weapons in World War II. Such weapons were considered the backbone of the new warfare, in which superior technology, at the ready, rather than latent productive capability, was the key to military success. Weapons research, development, and production became the core activities of the services.

The second part of the problem of weapons was the mode of production. The new weapons were largely the product of university laboratories and industry. The critical resources for building weapons were external to the services. How to relate to this "market" of resources to research, develop, and produce weapons was a key issue for the services--especially for the Air Force which, compared to the Army and Navy, had a less-developed system of laboratories and arsenals. Like the corporation, the services faced a series of interrelated problems involving technology, knowledge, the organization of production, and scale of operations. And likewise, the services tried variants of the strategies identified by Chandler and

Sklar: internalizing parts of the market, inventing new organizational forms, creating a management class, and trying to reconfigure political understandings to secure the place of the services in the postwar political economy. The military mediated important shifts in political economy. Within their context they "integrated backward" to sources of technology and knowledge production, and "integrated forward" to forums of national policy-making.[8] The services were the institutional actors defining on a day-to-day basis the set of relations concerned with preparedness and weapons production.

For a variety of reasons, the institutional leverage and autonomy of the services only diminished in small increments through the 1950s.[9] As an example, the RDB never succeeded in curbing service interests in its area of responsibility, quietly going out of business in 1953. The Secretary of Defense only gained appreciable powers to control service research and development in the last years of the Eisenhower administration.[10] Yet despite the importance of the military services in the American polity there are no studies of them either collectively or indi-

8. Samuel Huntington also uses the analogy of the corporation to describe the postwar services. On the use of public relations and coalition building to "integrate forward" see Samuel P. Huntington, *The Common Defense: Strategic Programs in National Politics* (New York: Columbia University Press, 1961), chapters 28-30.

9. For example, on the Air Force in the defense establishment see George M. Watson, *The Office of the Secretary of the Air Force, 1947-1965* (Washington, D.C.: Center for Air Force History, 1993).

10. For an outline of the balance of control between the Secretary of Defense and the services in research and development through the 1950s see Herbert York and G. Allen Greb, "Military Research and Development: A Postwar History," *Bulletin of the Atomic Scientists* (January 1977):13-26.

vidually that are comparable to those of Chandler or Sklar.[11] The literature of science and technology has increasingly elaborated the nexus between military services and university research sites, as well as the intersection of elite science, Congress, and the President in the development of science policy. The political science and sociology literature has given us aggregate views of the impact of military spending, as well as theoretic accounts of how the complex of military, academia, and industry have sustained a mutually beneficial and reinforcing political economy. Yet historical and analytic insight into the services as institutions and as agents and sites of change is incomplete.

Such context is critical for understanding the development of RAND and its relation with the Air Force before and after the start of the Korean War. RAND's work on nuclear strategy has been well documented.[12] But this literature, while important to understanding one aspect of RAND and of the history of the Cold War, does not address the broader scope of RAND's development of air-warfare science and its connection to Air Force management of the research, development, and production of weapons.

11. The closest approximation to such thorough institutional studies is the work of Samuel Huntington. See Samuel P. Huntington, *The Soldier and the State: The Theory and Politics of Civil-Military Relations* (Cambridge: Harvard University Press, 1957); and *The Common Defense: Strategic Programs in National Politics,* note 8.

12. See Bruce Smith, *The RAND Corporation* (Cambridge, MA: Harvard University Press, 1965); Fred Kaplan, *Wizards of Armageddon* (New York: Simon and Schuster, 1983); and Gregg Herken, *Counsels of War* (New York: Alfred A. Knopf, 1985).

In the years before the Korean War, despite the waverings of Air Force leadership, RAND held to the view that purposeful, scientific planning was required to knit together the service, industry, and academia to prepare for total war. RAND staff such as Williams, Collbohm, and Paxson felt a special sense of mission to define the tools and methods for such planning.[13] No other agency, either by charter or inclination, was examining the broad implications of planning for total war--despite the concept's prominence in the period's rhetoric--with the same commitment and focus.[14] In the literature on RAND an appreciation of this organizing principle for the project, and its connection to Arnold's and Bowles's attempted reforms of the Air Staff, is absent or muted.[15] One contribution of this dissertation

13. Recall, for example, Warren Weaver's perception of RAND's mission in Chapter IV: either the service should limit RAND's scope of responsiblity, Weaver argued, or RAND should be the nucleus of a newly created national planning group that would embrace all of the military establishment. In the absence of such sound government organization, Weaver thought, "Rand is forced, by circumstances, to approximate [this] kind of approach to its job" and "they have the paradox of trying to run, under AAF contract, a sort of scientific-industrialist-economist-political scientists-Army-Navy-State Department-White House job from Santa Monica, under the auspices of three or four aircraft companies, and with no dependable assurance of continuity."

14. As an example, Willis Shapley, an analyst with the Bureau of the Budget in the 1940s and 1950s, recalled his enthusiasm for Paxson's work. Shapley envisioned the nascent practice of systems analysis as a means for evaluating and coordinating the myriad programs of the whole National Military Establishment. In a budgetary sense this was the charge of the Bureau; but neither it nor any other group (such as the RDB) was in a position or had the assessment tools to provide such control. See Willis Shapley, Oral History Interview, Glennan-Webb-Seamans Project, NASM.

15. See Smith, *The RAND Corporation*, note 12; Kaplan, *Wizards of Armageddon*, note 12; and Herken, *Counsels of War*, note 12. Two recent accounts are more sensitive to the development of systems analysis at RAND but fail to place it in the context of Air Force organizational changes and problems. See David Hounshell, "The Cold War, RAND, and the Generation of Knowledge, 1946-1962," *Historical Studies in the Physical and Biological Sciences* 27 (1997):237-267; and David R. Jardini, "Out of the Wild Blue Yonder: The RAND Corporation's Diversification into Social Welfare Research, 1946-1968" (Ph.D. diss., Carnegie Mellon University, 1996).

is to set RAND's origins and early development in the context of the problems and the motivations of RAND and Air Force principals in the first years after World War II.

This contextual understanding needs to be extended to the period after the start of the Korean War. While RAND's and the Air Force's ambitions for systems analysis diminished after the early 1950s, this activity still was central to the corporation's work life and its relations with the service. Over 1951-1952 RAND completed its most well-known systems analysis, *The Selection and Use of Strategic Air Bases*, conducted by a team led by Albert Wohlstetter.[16] This study analyzed a more limited problem than the earlier *Strategic Bombing Systems Analysis*. While Paxson had dropped consideration of overseas bases from his study because of SAC's preference to launch attacks from the United States, Wohlstetter made such bases his focus. As noted in Chapter V, given the ranges of bombers then available, the JCS and the Air Force had to rely on intermediate airfields in planning air strikes against the Soviet Union. Wohlstetter's insight was to examine in the detail the role of these bases and consider the impact on the United States air campaign if the Soviets destroyed them in a surprise attack. Wohlstetter's accomplishment was to integrate a crucial question of strategy with an assessment of the optimum location and materiel requirements for intermediate bases. His

16. Although most of the work on the study was completed in 1952 it was not published until 1954. A.J. Wohlstetter, F.S. Hoffman, R.J. Lutz, and H.S. Rowen, *Selection and Use of Strategic Air Bases*, 1954, RAND Publication R-266.

recommendations were eventually accepted by the service and reduced substantially the funds the service planned to allocate for that purpose.[17]

The basing study sparked RAND's study of nuclear strategy issues in the 1950s. But it also inspired some of the RAND staff to codify the methodological practices associated with systems analysis through a course to be offered to Air Force officers. The course was not to train new practitioners but to educate the officers on how to understand and use the RAND-type analyses presented to them. Experience with the Paxson and other studies had demonstrated the need for creating within the service an audience of knowledgeable consumers who could appreciate systems analysis on its own terms. Planning for the course began in 1954. It was offered several times beginning in 1956 and featured lectures by staff who had been closest to the earlier systems analyses. The lectures were published as a book in 1964, exposing non-military audiences to RAND's methods for analyzing complex technical and social systems.[18] The expanded application of systems analysis to domestic and urban problems has been studied in part.[19]

17. The most thorough account of the basing study is in Bruce R. Smith, *The RAND Corporation*, note 12, pp.195-240. The methodology of the Wohlstetter study differed from that of Paxson's bombing analysis in a crucial respect. The focus was on current practices in the use of overseas bases as opposed to an examination of some future state of affairs. The immediate relevance of Wohlstetter's study to Air Force planning, resource allocation, and strategy was regarded as one of its most powerful, significant contributions.

18. E.S. Quade, ed., *Analysis for Military Decisions* (Chicago: Rand McNally & Co., 1964.

19. See David R. Jardini, "Out of the Wild Blue Yonder," note 15.

How systems analysis intersected with Air Force interests in the 1950s still needs to be examined. The connections between RAND and the Air Staff became increasingly regularized and formal. Despite the close working relationships developed during the 1940s through periodic RAND-Air Staff briefings, participation in service boards and committees, work on specific problems such as Paxson's study, and a stream of technical and progress reports, the Air Force sought closer ties. Starting in 1951 RAND established a small liaison office under the Deputy Chief of Staff, Development (a new but less powerful incarnation of the 1946-1948 LeMay post), to assist in creating five- to ten-year plans for research, development, and production of technologies in areas crucial to the air force mission: strategic air, defense, reconnaissance, and tactical air.[20] Deciding this formal collaboration was insufficient, the Air Staff pushed for the establishment of a Military Advisory Group (MAG). Essentially a military version of RAND's civilian Board of Trustees, the MAG met with RAND twice a year to receive reports on the research program and to stress problems of interest to the service. These changes were inspired, in part, by the intensifying conflict with the Soviet Union and the increasing reliance on technology in United States military and fiscal planning, exemplified by Eisenhower's 1954 "New Look" policy.

These closer organizational ties and new problems confronting the service modified the ways in which RAND's research program intersected with the Air

20. For a broad outline of these events see Alan L. Gropman, "Air Force Planning and the Technology Development Process in the Post-World War II Air Force--The First Decade (1945-1955)," in *Military Planning in the Twentieth Century*, H.R. Borowski, ed. (Washington, D.C.: Office of Air Force History, 1986):154-230.

Force's interests and politics. This might be examined at two levels. One would pertain to RAND's research departments, which considered themselves analogous to university departments and active participants in contributing to their professional disciplines. This was particularly the case for the mathematics and economics departments.[21] How Air Force problems and interests interacted with research choices and methods would add to our understanding of the larger pattern of military patronage and discipline development in the Cold War. The other focus for additional study would be the changing ways in which air warfare as a science was conceived, in relation to the research agendas of the individual departments and to Air Force interests. This issue was particularly germane for RAND's self image through the 1950s. RAND leadership continuously tried to define their enterprise as objective and independent of the Air Force--a prerequisite for claiming scientific authority for systems analyses--but they always were aware that their symbiotic relationship with the Air Force and the inescapable inclusion of politics in their research domain made this ideal problematic.

21. On the RAND work in mathematics see Bruno Augenstein, *A Brief History of RAND's Mathematics Department and Some of Its Accomplishments*, 1993, RAND Publication DRU-218-RC; for an overview of the role of RAND economics department in postwar history of that discipline see Robert J. Leonard, "War as a "Simple Economic Problem": The Rise of an Economics of Defense," in *Economics and National Security: A History of Their Interaction*, C.D. Goodwin, ed. (Durham: Duke University Press, 1991):261-284; as well as Philip Mirowski, "When Games Grow Deadly Serious: The Military Influence on the Evolution of Game Theory," ibid, pp. 227-256. RAND Economics Department head Charles Hitch was instrumental in advancing the idea that the powerful impact of military expenditures on the domestic economy created a new field of inquiry. See Charles J. Hitch, *The Economics of Defense in the Nuclear Age* (Cambridge, MA: Harvard University Press, 1960).

In 1954, as RAND prepared for its first meeting with the MAG, Frank Collbohm, Associate Director J.R. Goldstein, and consultant James Allen discussed how they could present the corporation in the best possible light. Collbohm started an exchange of comments on the inseparability of military interests from RAND's professional activity:

> Collbohm: What we have here is an organization of professional military scientists, if you can call them that. It's their profession.
> Allen: Well, would you say we created a new profession?
> Goldstein: I think so.
> Collbohm: We have a mathematician who is not just a mathematician; he's a military mathematician.
> Allen: And you know what you could say to a military group? You could say, "Now look, we can say this to you, but we wouldn't ever want to say it to our scientists because they'd rebel. They'd deny it, but in effect what the military has gotten out of RAND is the development of a group of military statisticians, military mathematicians, military social scientists....The scientists who would normally yell against this type of identification are accepting it and liking it....Now we are able to look back and say, "Holy gee, we've developed a race of military scientists."[22]

This exchange was emblematic of the merging of scientific and military values that informed RAND from the beginning; of the corporate tension this created; and of the new and expanded ways in which the military, science, and technology interpenetrated during the Cold War.

The ideology and politics of preparedness made research, development, and production of weapons and state-market relations central problems in the period 1945-1950. This context motivated RAND's founding and development, as well as that of other institutions of the period, including the Research Board for National Security, the proposed National Science Foundation, the Office of Naval Research,

22. "RAND Question List," February 1954, pp. 11-13, unboxed, RAND Corporation.

the National Military Establishment's RDB, and others.[23] But RAND, first through Arnold and Bowles, and then through RAND's own leadership, forged distinctive responses to postwar organizational challenges. Building on a deep acceptance of the tenets of preparedness and total war, the RAND principals translated that perspective into specific, unique models for integrating the military with industry and academia--Bowles's trade association strategy and then the attempt to create a science of air warfare.

As an integral element of the Air Force, RAND was positioned in a bureaucracy that enabled (and thwarted) the testing of these different prescriptions. Both strategies were, in part, a response to the decentralized and pluralistic character of decision-making in the military and in national political forums. The production and use of modern weapons seemed to call for integration and coordination among American institutions, yet political tradition offered relatively ineffective tools to achieve these ends. Statist impulses had to contend with a countervailing ideology that limited centralized control, preserving the prerogatives of industry and academia. Such impulses also had to contend with practical limitations. They

23. On the Research Board for National Security see Daniel J. 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* (1975):20-47; on NSF see Kevles," The National Science Foundation and the Debate Over Postwar Research Policy," *Isis 68* (1977):5-26; and J. Merton England, *A Patron for Pure Science: The National Science Foundations Formative Years, 1945-1957* (Washington, D.C.: NSF, 1982); and on the ONR see Sapolsky, note 1. On the origins of the JRDB and RDB see Allan Needell, *Cold War Science and the American State: Lloyd V. Berkner and the Balance of Professional Ideals*, (unpublished manuscript, courtesy of the author).

were managerially difficult, if not unworkable.[24]

The strategies of the trade association and of the military as a domain of research also reveal the complex status of technology in postwar thinking. The ideology of preparedness was not a claim that there was an autonomous dynamic of weapons technology tending towards innovation. It was a contingent claim: such innovation was a consequence of the competition of international life. The strategies outlined here were attempts to organize, within the limits of American political culture, the resources to meet this perceived state of affairs. The development of technology was a matter of choice and management. But the ideology of preparedness also encapsulated a view that the defining problems of the service were technological. This intellectual move lay behind the idea of air warfare as science. Technological objects and their interrelation constituted a domain of phenomena akin to those of natural scientific domains described by physics and mathematics, and hence could be studied in similar ways. The result was a conceptual framework in which technology was an enterprise to be directed and yet defined the range of military problems and their solutions. This view of technology in modern war informed the RAND-Air Force relationship and their approach to the state-market problem through the 1950s.

24. A useful analysis of this issue for the period of the Cold War by a political scientist is Aaron Friedberg, "Why Didn't the United States Become a Garrison State," *International Security 16* (1992):109-43. The case of the National Science Foundation has also been examined from the perspective of pluralism in American political decision-making. See Daniel Lee Kleinman, *Politics on the Endless Frontier: Postwar Research Policy in the United States* (Durham, NC: Duke University Press, 1995). A more general analysis is Ellis W. Hawley, "The New Deal and the Anti-Bureaucratic Tradition," in R. Eden, ed., *New Deal and Its Legacy: Critique and Reappraisal* (New York: Greenwood Press, 1989):77-92.

RAND's first years and its relationship with the Air Force reveal the halting, experimental process of refashioning the Air Force and its relation to the market as weapons research, development, and production became core activities of the service. The critical fact was that the Air Force was not institutionally self-sufficient in these activities. Weapons research, development, and production required constructing specific, stable relations with academia and industry. Through RAND the service explored novel means to achieve this end. RAND was not the only site within or associated with the Air Force at which these questions were worked out. But it was the place in which these questions were most broadly and directly engaged.

A NOTE ON SOURCES

This study drew principally upon the holdings of four repositories: The RAND Corporation, the National Archives and Records Administration, the Office of Air Force History, and the Library of Congress. Much of RAND's written output, and related memoranda, letters, reports in Air Force holdings, was classified. A substantial number of primary sources cited in the dissertation were made available for the first time through a series of declassification requests.

THE RAND CORPORATION

RAND has only recently initiated the process of establishing a corporate archive. It holds collections of individual researchers and administrators as well as some general corporate materials relating to the Board of Trustees, annual reports, in-house newsletters, and other materials. The most useful collections for this study were:

Frank Collbohm Papers (RAND's first director)

Lawrence Henderson Papers (RAND Associate Director and Head of the RAND Washington Office)

J.R. Goldstein Papers (RAND Associate Director)

Brownlee Haydon Papers (Assistant to the Director and Head of Publications)

Also important is a separately administered collection of RAND publications. These include informal documents intended only for internal circulation as well as formal reports prepared for the Air Force or other external audiences. Each has a unique identifying number which is referred to when cited.

The author also conducted a number of oral history interviews with RAND staff and some Air Force personnel. All interviews are on deposit in the Department of Space History, National Air and Space Museum and at RAND. These interviews have been used primarily as background and only sparingly cited.

NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

NARA is the primary repository for records on the Air Force and its relations with RAND. Several record groups were used:

RG 18 (Records of the Army Air Forces)

RG 340 (Records of the Secretary of the Air Force)

RG 341 (Records of the Air Staff)

Also relevant were selected records from the Department of Defense (RG 330) and the Joint Chiefs of Staff (RG 218).

OFFICE OF AIR FORCE HISTORY

Relevant resources here included: annual and bi-annual histories of individual service offices and commands; papers of selected Air Staff personnel; unpublished historical studies; and oral history interviews with officers at several levels of the

Air Force hierarchy. Equally important, the history office is the conduit for gaining access to the service's post-1954 records not available through NARA.

LIBRARY OF CONGRESS

The Library of Congress holds the personal papers of a number of Air Force leaders. Several were useful: Henry Arnold Papers, Curtis LeMay Papers, Carl Spaatz Papers, Hoyt Vandenberg Papers, and the Muir Fairchild Papers. Other important collections include: the Vannevar Bush Papers, John Von Neumann Papers, and the Edward Bowles Papers.

The last collection was especially crucial to the early chapters of this dissertation. Throughout the dissertation, however, citations to the Bowles Papers indicate the National Air and Space Museum as repository. Through a special arrangement with Edward Bowles several boxes of his materials were sent to the Museum before their donation to the Library of Congress, copied, and then forwarded to the Library. Citations to the Bowles Papers refer to the Museum duplicates of his materials.

TRUMAN PRESIDENTIAL LIBRARY AND UNIVERSITY ARCHIVES

Also utilized were the Stuart Symington Papers at the Truman Library. Despite the fact that many of RAND's published and unpublished records were classified, some materials have found their way into university collections. These include the L. DuBridge Papers (California Institute of Technology) and the Philip Morse Papers (Massachusetts Institute of Technology) both documenting some aspects of the work of members of the RAND Board of Trustees. The Louis Ridenour Papers (University of Illinois) were useful on Ridenour's role as consultant to RAND and the Air Force.

UNPUBLISHED MANUSCRIPTS

Extremely valuable as background for the treatment of Edward Bowles and Vannevar Bush, particularly on the workings of the Joint Research and Development Board and the Research and Development Board, was Allan Needell's unpublished manuscript "Cold War Science and the American State: Lloyd V. Berkner and the Balance of Professionals Ideals." Dr. Needell is a curator in the Division of Space History, National Air and Space Museum.

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