

Governing, Financing, and Planning Cancer Virus Research: The Emergence of Organized Science at the U.S. National Cancer Institute in the 1950s and 1960s*

YI Doogab†

Introduction

It was the renowned sociologist Daniel Bell who resurrected the term “fiscal sociology” from the economist Joseph Schumpeter. Bell argued that the fiscal history of a society would provide insight “into the laws of social being and becoming and into the driving forces of the fate of nations, as well as into the manner in which *concrete* conditions and in particular, organizational forms, grow and pass away.”¹ For Bell, the public finances of the modern tax state, or the ways in which the state collected and distributed taxes for common expenditure, had come to the fore in the United States during the course of the twentieth century: the American “public household,” as he called the fiscal operation of the United States, had expanded enormously in order to meet common and national needs, from the government’s Keynesian economic policy in the 1930s, the underwriting of science and technology in the 1950s, all the way to the growth of social and welfare policies in the 1960s. As he saw it, state finance provided an alternative to the market, which primarily sought to serve diverse private and individual wants. Thus Bell claimed that the fiscal history and

Received July 3, 2016; Reviewed August 11, 2016; Accepted August 12, 2016.

* This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2014S1A5A8019101). I would like to thank David Cantor, Angela Creager, Douglas Lowy, and Robin Scheffler, for their guidance, help, and comments at the various stages of my research. KJHS’s editor, Jongtae Lim, and its three anonymous referees provided useful corrections and helpful suggestions that greatly improved my paper.

† Seoul National University, doogab@snu.ac.kr.

¹ Daniel Bell, *The Cultural Contradictions of Capitalism* (New York: Basic Books, 1976), 227. Bell cited Joseph Schumpeter’s 1918 article, “The Crisis of the Tax State,” which was translated by W. F. Stolper and R. A. Musgrave and reprinted in *International Economic Papers*, no. 4 (New York: Macmillan, 1954), 5-38. For a synthetic review of fiscal sociology, see John L. Campbell, “The State and Fiscal Sociology,” *Annual Review of Sociology* 19 (1993), 163-185.

sociology of the state would provide an insight into how the nation's citizenry defined its collective goals, mobilized its political forces and financial resources, and found concrete organizational forms to meet its common needs.

It is noteworthy that Bell pointed out that the post-World War II expansion of federal support for science and technology could provide an exemplary window into a fiscal history of science in the United States, one that could illuminate how science policy became a matter of government policy, and how state finance made science and technology an integral part of the fulfillment of the nation's common goals, such as economic growth and innovation, military defense, and the promotion and security of health. This paper aims to examine one key episode in the fiscal history of the nation's biomedical research in the 1950s and 1960s, a period when rapidly growing federal spending on medical and biological research prompted policy discussions as to its proper goals and organizational arrangements. The National Cancer Institute (NCI) of the National Institutes of Health (NIH), the nation's largest health-related research organization, emerged as a key institutional focus for such discussions.

This paper analyzes the NCI's involvement in cancer virus research in the 1950s and 1960s, which ultimately led to the establishment of the Special Virus Leukemia Program (SVLP) at the NCI in 1964, in terms of fiscal and organizational dimensions. The SVLP started as an experiment in research management that aimed to guide a national program of goal-oriented research on viral oncology. Historians have argued that the NCI's new style of management of biomedical research and clinical trials reflected an overwhelming influence of industrial practices and values after WWII.² Those organizational and managerial techniques have been situated in the context of the industrialization of biomedicine, necessitated by the growing scale of biomedical enterprise. The close interaction between the NCI, industrialists, and clinical hospitals in turn has been analyzed as a precursor of the commercialization of biomedicine, leading to the advent of large-scale clinical trial protocols and the

² Robert F. Bud, "Strategy in American Cancer Research after World War II: A Case Study," *Social Studies of Science* 8:4 (1978), 425-459. For an excellent overview of the NCI's chemotherapy program, see Peter Keating and Alberto Cambrosio, *Cancer on Trial: Oncology as a New Style of Practice* (Chicago: University of Chicago Press, 2012); and Ilana Löwy, "'Nothing More to Be Done': Palliative Care Versus Experimental Therapy in Advanced Cancer," *Science in Context* 8:1 (1995), 209-229. On the NCI's virus cancer research within the context of industrialization in biomedical research, see Jean-Paul Gaudillière, "Oncogenes as Metaphors for Human Cancer: Articulating Laboratory Practices and Medical Demands," in Ilana Löwy ed., *Medicine and Change: Historical and Sociological Studies of Medical Innovation* (Montrouge, France: John Libbey Eurotext/Les Editions INSERM, 1993), 213-248.

emergence of the biotech industry.³ More recently, Robin W. Scheffler has analyzed the political and scientific imperative for the acceleration of cancer virus research, which prompted the prolific introduction of new managerial apparatus at the NCI, such as systems analysis.⁴

This paper examines the fiscal and organizational history of the SVLP in order to illuminate how the NCI's new fiscal and managerial arrangements mediated between the government's obligation, scientists' creative needs, and the public's call for medical progress. Inspired by the development of Jonas Salk's polio vaccine in 1955, the nation's scientists, politicians, citizenry, and voluntary health organizations like the American Cancer Society (ACS) anticipated and called for another laboratory-based medical breakthrough, especially in the area of cancer.⁵ This paper first looks at the administrative discussions held at the NIH in order to examine how the NIH tried to address a growing call for medical progress. Over the years, the Research Administration Discussion group at the NIH explored a broad array of literature on the nature of science, the relationship between science and society, the role of the federal government in science, and the management of science in a research organization.⁶ This paper's analysis of the discussions about the nature and mission of the NIH as

³ For the role of the NCI's chemotherapy program in the emergence of clinical trials protocols, see Peter Keating and Alberto Cambrosio, "From Screening to Clinical Research: The Cure of Leukemia and the Early Development of the Cooperative Oncology Groups, 1955-1966," *Bulletin of the History of Medicine* 76:2 (2002), 299-334; and idem., "Cancer Clinical Trials: The Emergence and Development of a New Style of Practice," *Bulletin of the History of Medicine* 81:1 (2007), 197-223. On the role of the NCI's chemotherapy program in the mass-production and standardization of mice as a model organism, see Jean-Paul Gaudillière, "Disciplining Cancer: Mice and the Practice of Genetic Purity," in Jean-Paul Gaudillière and Ilana Löwy eds., *The Invisible Industrialist: Manufactures and the Production of Scientific Knowledge* (London: Routledge, 1998), 209-249.

⁴ Robin W. Scheffler, "Managing the Future: The Special Virus Leukemia Program and the Acceleration of Biomedical Research," *Studies in History and Philosophy of Biological and Biomedical Sciences* 48: Part B (2014), 231-249. For a historical analysis of systems analysis, see David A. 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 Agatha Hughes and Thomas Hughes, eds., *Systems, Experts, and Computers: The Systems Approach in Management and Engineering, World War II and After* (Cambridge, MA: The MIT Press, 2000).

⁵ Angela N. H. Creager, "Mobilizing Biomedicine: Virus Research between Lay Health Organizations and the U.S. Federal Government, 1935-1955," in Caroline Hannaway ed., *Biomedicine in the Twentieth Century: Practices, Policies, and Politics* (Amsterdam: IOS Press, 2008), 171-201.

⁶ "Agenda Topic: First Year: The Nature of Science and Research in Relation to Society," January 23, 1957, Box 12, Carl Baker Papers, Office of NIH History [hereafter cited as Baker Papers].

a research organization provides the institutional and political context for the emergence of “developmental research” as an exemplary organized science. Indeed, the NCI’s initiatives in the areas of research management and planning in the late 1950s and early 1960s opened a way to a goal-oriented biomedical project.

This paper then situates the increasing use of the contract mechanism for cancer virus research within the context of the nation’s shifting biomedical administration and research policy that would encourage the federal government to “purchase” goal-oriented research and technical solutions amid the public’s call for relevance in scientific research. The federal government, as historians like Nathan Reingold and Angela Creager point out, emerged as a key site where the nation’s commitment was translated into a concrete public scientific enterprise after WWII.⁷ The NCI, as this paper will show, became a central institution where scientists’ demands for innovative cancer research, the federal government’s initiative for serving the nation’s promotion of science and health, and the public’s call for medical progress were mediated and translated into a target-oriented cancer virus research project, namely the SVLP. Indeed, through its direct appeal to Congress, the NCI was able to obtain a special financing scheme to support target-oriented cancer virus research. The NCI in turn introduced a system of contracts with academic, industrial and semi-industrial companies for planning, organizing, and managing the SVLP.⁸ It was a radical departure from the traditional system of biomedical research support administered by the NIH through a system of grant-giving that had gone on since WWII. The SVLP implemented large-scale, goal-oriented biomedical research by adopting the industrial mode of research management and operation. This new style of biomedical research at the NCI was instrumental in the translation of the public’s increasing call for medical progress into target-oriented biomedical research in the 1960s, providing an important institutional background for the Nixon Administration’s War on Cancer campaign in the 1970s.⁹

⁷ Nathan Reingold, “Science and Government in the United States since 1945,” *History of Science* 32:3 (1994), 361-386; and Angela N. H. Creager, *Life Atomic: A History of Radioisotopes in Science and Medicine* (Chicago: University of Chicago Press, 2013).

⁸ To be sure, the contract mechanism had been productively administered by other federal agencies during and after WWII. The Atomic Energy Commission (AEC) and the National Aeronautics and Space Administration (NASA), for example, adopted the contract mechanism for post-WWII nuclear energy and aerospace engineering projects. See Walter A. McDougall, *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985); and Robert W. Seidel, “A Home for Big Science: The Atomic Energy Commission’s Laboratory System,” *Historical Studies in the Physical and Biological Sciences* 16:1 (1986), 135-175.

⁹ Stephen P. Strickland, *Politics, Science, and Dread Disease: A Short History of United States Medical Research Policy* (Cambridge, MA: Harvard University Press, 1972); and Richard A.

Organized Science: Management and Finance in Biomedical Research

The NIH, a research agency of the U.S. Department of Health, Education, and Welfare (DHEW), emerged as the single largest public patron of biomedical research after the conclusion of World War II. In 1946, the NIH took over the research programs and budgets in the area of biology and medicine from the Office of Scientific Research and Development (OSRD), a federal agency created to coordinate the nation's scientific research for military purposes during WWII.¹⁰ The public enthusiasm for biomedical research, as evidenced by the OSRD's critical contribution to the development of penicillin and anti-malaria drugs, underlined the enormous expansion of federal investment in health-related research.¹¹ By 1950, the NIH budget was \$52 million, of which \$36 million was assigned for extramural research, training, and construction support. By 1955, the budget had increased to \$82 million, and between 1955 and 1960, NIH programs expanded more than fivefold, reaching a level of \$430 million. In 1965, the total budget of the NIH exceeded \$1 billion.

This "socialization of research" in biomedicine, or the rise of biomedical research after WWII, did not mean "endless" support for pure scientific research.¹² Rather, the growth of the NIH underlined the significance of the public mandate to support biomedical research as a programmatic means to foster laboratory-based medical breakthroughs. By building on wartime medical successes, such as the development of penicillin, leaders of voluntary health organizations including the National Foundation for Infantile Paralysis (NFIP) and the ACS, politicians, and private citizens cultivated cultural and political support for curing diseases through scientific inves-

Rettig, *Cancer Crusade: The Story of the National Cancer Act of 1971* (Princeton: Princeton University Press, 1977).

¹⁰ Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942-1945: A Political Interpretation of Science-the Endless Frontier," *Isis* 68:1 (1977), 5-26.

¹¹ On penicillin, see Robert Bud, *Penicillin: Triumph and Tragedy* (Oxford: Oxford University Press, 2007). For a historical analysis of the U.S. anti-malaria project and its organizational impact on the NIH, see Leo B. Slater, *War and Disease: Biomedical Research on Malaria in the Twentieth Century* (New Brunswick: Rutgers University Press, 2009).

¹² Richard C. Lewontin, "The Socialization of Research and the Transformation of the Academy," in Hannaway ed., *Biomedicine in the Twentieth Century* (cit. n. 5), 9-25. For a historiographical discussion on the rise of biomedicine, see Peter Keating and Alberto Cambrosio, *Biomedical Platforms: Realigning the Normal and the Pathological in Late-Twentieth-Century Medicine* (Cambridge, MA: MIT Press, 2003); and Ilana Lowy, "Historiography of Biomedicine: 'Bio,' 'Medicine,' and in Between," *Isis* 102:1 (2011), 116-122.

tigations. The political support for medical progress in turn undergirded the development of large-scale federal patronage of biomedical research.¹³ The NIH's organizational structure in turn reflected its public mandate to conquer diseases through laboratory investigations. The so-called "disease category" became an institutional basis for the NIH, as its individual institutes organized around diseases like cancer, heart disease, and mental illness.¹⁴ By the early 1950s, the NIH itself had evolved into several "disease categorical" institutes, which included institutes such as the National Cancer Institute, the National Heart Institute, and the National Institute of Mental Health. Indeed, the proliferation of categorical institutes at the NIH reflected the post-WWII political context for federal support in biomedical research.

How was the NIH able to achieve its medical mandate? The federal agencies, as the renowned government administrator Charles V. Kidd noted, used two financing means to advance the national interest—the purchase of research, and the support of research. The term "purchase of research" meant that the purchasing government agency first defined the problem it wanted to have solved and then arranged a contract with an academic or industrial research organization. In this way, the government agency utilized universities and their faculties "essentially as it would use the resources of an industrial research organization."¹⁵ The term "supported research" implied "aid to universities to advance research of interest to faculty members as distinguished from research of value to the nation as a whole," and it was meant to "ensure that an activity of great value to the nation as a whole is not neglected."¹⁶ The initiative for supported research would lie with an individual researcher, and the NIH developed a large system of grants that would support biomedical researchers in the post-WWII years. In fact, the NIH rarely utilized the contract mechanism in order to purchase research until the mid-1950s.

The NIH traditionally administered a peer-review grant system that would support biomedical research initiated by individual scientists in the academy with a general expectation that fundamental biomedical research would medically payoff in the end. It was relatively undirected support in that it would fund scientific research with a general framework for medical progress without requiring any specific goals. This system of grants was managed through a dual review process: technical review groups, called "study sections," composed entirely of scientists, would review individual applications in terms of their scientific merit; after the study section's recommendation, the individual grant would be awarded if it was approved by any one of

¹³ Creager, "Mobilizing Biomedicine" (cit. n. 5).

¹⁴ Buhm Soon Park, "Disease Categories and Scientific Disciplines: Reorganizing NIH Intramural Program, 1945-1960," in Hannaway ed., *Biomedicine in the Twentieth Century* (cit. n. 5), 27-58.

¹⁵ Charles Vincent Kidd, *American Universities and Federal Research* (Cambridge, MA: Belknap Press, 1959), 6.

¹⁶ *Ibid.*, 6.

ten National Advisory Councils, which consisted of both scientists and laymen. This grant system was maintained by NIH extramural funds that disbursed about two-thirds of NIH funds, and as such it was primarily designed to support autonomous and creative science by providing funds to small and individual scientists, and to “undirected” research projects.¹⁷

As a result, the biomedical research community in general had not experienced large-scale coordinated contract research. Some believed that the unpredictable nature of biological experimentation and the complexities of biological organisms would defy any clearly targeted-research. They claimed that individually initiated grant systems would work best in making progress in unpredictable experimentation. Moreover, many research scientists abhorred large-scale, government directed research projects, even when they had participated in war-time goal-oriented projects for antibiotics, anti-malaria drugs, and blood fractionation.¹⁸ Edwin Cohn, a renowned Harvard biochemist who led the Plasma Fractionation Project during WWII, warned that the “success of many of the undertakings [by the OSRD] depended, in my estimation, upon the fact that both the members of the committees and the responsible investigators were scientists with a long tradition of the freedom necessary to ensure the exploitation of even a tactical advance.”¹⁹ Cohn further claimed that “creative scientific research depends upon the imagination and technical resourcefulness of the investigator. He can be chosen by a committee competent to judge of his quality. He cannot be directed.”²⁰ As the renowned philosopher of science Michael Polanyi puts in his *Logic of Liberty*, “the pursuit of science can be organized, therefore, in no other manner than by granting complete independence to all mature

¹⁷ United States Department of Health, Education, Welfare, Office of the Secretary, *The Advancement of Medical Research and Education through the Department of Health, Education, and Welfare: Final Report of the Secretary's Consultants on Medical Research and Education* (Washington, D.C.: Department of Health, Education, and Welfare, 1958), 56.

¹⁸ Bud, *Penicillin* (cit. n. 11); and Slater, *War and Disease* (cit. n. 11). For Edwin Cohn's blood research during WWII, see Angela N. H. Creager, “Biotechnology and Blood: Edwin Cohn's Plasma Fractionation Project, 1940-1953,” in Arnold Thackray ed., *Private Science: Biotechnology and the Rise of Molecular Sciences* (Philadelphia: University of Pennsylvania Press, 1998), 39-62.

¹⁹ Edwin J. Cohn, “History of the Development of the Scientific Policies of the University Laboratory of Physical Chemistry Related to Medicine and Public Health, Harvard University: A Memorandum on the Unwisdom of Projects and Reports (January 1952),” in Edwin J. Cohn ed., *A Collection of Pamphlets: Published to Record an Experiment in Organization for Research, Training, and Development in Science Basic to Medicine and Public Health* (Cambridge, MA: Harvard University Printing Office, 1952), 8.

²⁰ *Ibid.*, 8.

scientists.”²¹

At a broader level, commentators of science, including some leading academic scholars and scientists, began to look warily on the post-WWII relationship between the federal government and science. The rise of big science during the Cold War era, especially in physics, seemed to pose quite a challenge for scientists seeking to pursue creative and individual-initiated research under increasing administrative, organizational, and sometimes political demands.²² Some scientists programmatically adjusted to the demands that came from large-scale scientific projects, leading the “suburbanization” of physics, for example.²³ Even so, social scientists and cultural critics castigated organized science, as it would diminish the creative potential of individual scientists with its emphasis on tangible research objectives.²⁴ Moreover, the political climax of the Cold War, with its celebration of free inquiry, provided the critics of organized science ample political rhetoric and resources.²⁵ Like the biochemist Cohn, some scientists insisted that the beneficial outcome of science usually would come from unexpected findings or unrelated experiments driven by individual initiatives. Even the NIH’s participation in the polio crusade was characterized as part of a “Communistic, un-American ... scheme.”²⁶ The NIH only stepped in later, overseeing the large-scale clinical trials and industrial production of the polio vaccine.

In the mid-1950s, however, research administrators at the NIH and politicians wondered whether this system of “undirected” research grants, maintained by a large flow of individually initiated grant applications, was the best means of achieving medical goals. In a 1958 report on the nation’s biomedical research, for example, a system of grants emerged as a “central problem facing NIH.”²⁷ As the report noted, during and after WWII, other federal agencies successfully coordinated large-scale,

²¹ Michael Polanyi, *Logic of Liberty: Reflections and Rejoinders* (Chicago: University of Chicago Press, 1951), 89.

²² James H. Capshew and Karen A. Rader, “Big Science: Price to the Present,” *Osiris* 7 (1992), 3-25.

²³ For a recent reinterpretation of large-scale research during the Cold war, see Catherine Westfall, “Rethinking Big Science: Modest, Mezzo, Grand Science and the Development of the Bevalac, 1971-1993,” *Isis* 94:1 (2003), 30-56; and David Kaiser, “The Postwar Suburbanization of American Physics,” *American Quarterly* 56:4 (2004), 851-888.

²⁴ Steve Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago: University of Chicago Press, 2008).

²⁵ David A. Hollinger, “Science as a Weapon in *Kulturkämpfe* in the United States during and after World War II,” *Isis* 86:3 (1995), 440-454; and Jamie Cohen-Cole, *The Open Mind: Cold War Politics and the Sciences of Human Nature* (Chicago: University of Chicago Press, 2014).

²⁶ David M. Oshinsky, *Polio: An American Story* (Oxford: Oxford University Press, 2005), 189.

²⁷ DHEW, *The Advancement of Medical Research and Education* (cit. n. 17), 56.

multi-disciplinary, and goal-oriented techno-scientific projects in the area of atomic energy and space programs. Federal agencies, such as the Department of Defense, the Atomic Energy Commission, and the National Aeronautics and Space Administration, productively adopted the contract mechanism to achieve well-defined goals, such as the atomic bomb and the space ship.²⁸ The NIH, however, had essentially no research contract to coordinate directed research and development projects until the mid-1950s. As a result, the NIH had remained largely outside of a few of the most cherished goal-oriented post-WWII biomedical projects, such as the development of polio vaccines.

As the share of the federal government in research support grew exponentially after WWII (see Figure 1), however, biomedical scientists and research organizations, such as the NIH and research universities, became accountable for their research to the public. Voluntary health organizations, such as the NFIP and the ACS, with its disease-categorical initiatives, provided organized science with critical cultural, organizational, and political resources. At one level, the organization of the NIH, with its categorical institutes, reflected a disease-categorical mode of operations of voluntary health organizations. Thus through their novel mode of research support and public campaigns on dread diseases, voluntary health organizations, especially the ACS, were able to largely shape the post-WWII relationship between biomedical research, the federal government, and the public.²⁹ At another level, in its mode of accountability, the NIH resembled voluntary health organizations that directly drew their support from American citizens. The public, which provided broad support in biomedical research through private donations and taxation, called for relevance in biomedical research. A group of lay activists led by the ACS's Mary Lasker, for example, pressured the NIH to find tangible breakthroughs to defeat cancer, leading to the establishment of the Cancer Chemotherapy National Service Center (CCNSC) in 1955.³⁰ Thus, in a situation when categorical research institutes were firmly established at the NIH, the administration of biomedical research under the framework of disease categories became a significant issue for politicians, government officials, and scientists themselves.

²⁸ Peter Galison and Bruce Hevly, *Big Science: The Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992).

²⁹ Creager, "Mobilizing Biomedicine" (cit. n. 5); and Kenneth E. Studer and Daryl E. Chubin, *The Cancer Mission: Social Contexts of Biomedical Research* (Beverly Hills: Sage Publications, 1980).

³⁰ Keating and Cambrosio, *Cancer on Trial* (cit. n. 2). For a broader cultural and political history of cancer research in the post-WWII years, see James T. Patterson, *The Dread Disease: Cancer and Modern American Culture* (Cambridge, MA: Harvard University Press, 1987); and Rettig, *Cancer Crusade* (cit. n. 9).

GROWTH OF NATIONAL INSTITUTES OF HEALTH APPROPRIATIONS

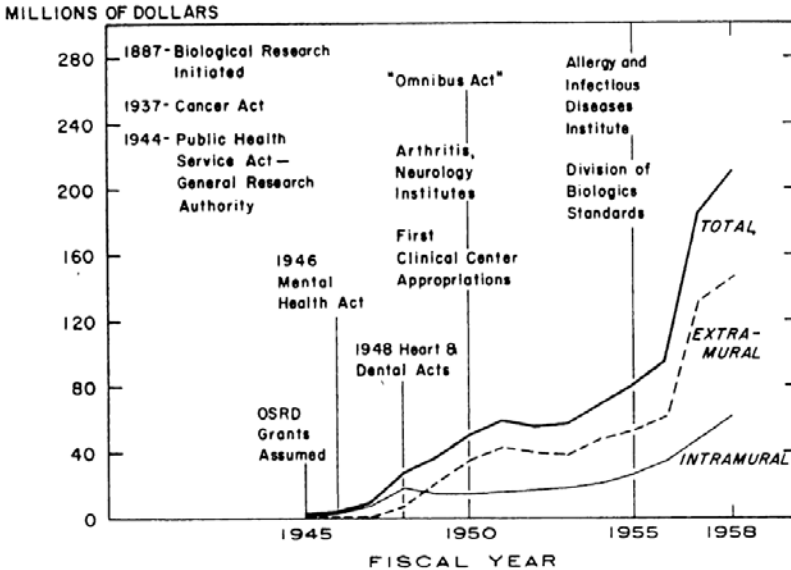


Figure 1. Growth of NIH Appropriations. [United States, Dept. of Health, Education, Welfare, Office of the Secretary, *The Advancement of Medical Research and Education through the Department of Health, Education, and Welfare: Final Report of the Secretary's Consultants on Medical Research and Education* (Washington, D.C.: Department of Health, Education, and Welfare, 1958), 56.]

The late-1950s saw increased scrutiny of the NIH's operations and a growing call for relevance for the NIH's research support toward medical progress, which led to the DHEW's study of the NIH's contribution and the Bayne-Jones Report.³¹ In response, a group of NIH scientists and research administrators formed a "Research Administration Discussion Group" in order to discuss how best "to assure a maximum of high quality research and at the same time to assure that progress is being

³¹ DHEW, *The Advancement of Medical Research and Education* (cit. n. 17); and Sejal S. Patel, "Methods and Management: NIH Administrators, Federal Oversight, and the Framingham Heart Study," *Bulletin of the History of Medicine* 86:1 (2012), 94-121. For an increasing call for relevance in scientific research, see Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (New York: Knopf, 1977), especially 413-416; and Toby A. Appel, *Shaping Biology: The National Science Foundation and American Biological Research, 1945-1975* (Baltimore: Johns Hopkins University Press, 2000).

made toward the goals” of tangible medical progress.³² In its first meeting, held on January 23, 1957, two leaders of this group introduced broader themes to the group’s meeting. Charles V. Kidd, Chief of the Office of Research Planning at the NIH, presented a paper titled “The Nature of Science and Its Relationships to Certain Aspects of Society.” Carl Baker, assistant to the associate director of the NIH provided his perspectives on conditions that affect the advancement of science.³³

As NIH administrators and scientists recognized, there seemed to be an inherent tension between directed and undirected scientific research that the NIH should accommodate managerially and financially. They were well aware of the unforeseeable nature of experimentation, and discussed how this unpredictable enterprise could be managed and ultimately led to achieve predetermined goals. They deliberated on what might be called “organized science,” or science done at research organizations, such as industrial and government laboratories. While they noted that the distinction between organized science and academic science seemed rather too arbitrary, NIH administrators noted that industrial and governmental scientists operated under the assumption that their work should contribute to the goals of the organization. Academic scientists, who often worked on their own research subjects through a system of grants, were at a different position in terms of their finance and accountability. At one level, the funding of organized science necessitated the contract mechanism that would purchase required technical skills and resources. At another level, organized science would be held accountable for the goals of an institution. Indeed, the management of science in an organizational setting, the group indicated, emerged as a “central problem especially for NIH: how to encompass an essentially individual and autonomous activity within a purposive arrangement of forms and goals.”³⁴

Baker, who soon became assistant director of the NCI, and had been actively leading the NIH research administration group, underlined the significance of research objectives in a research organization publicly mandated to achieve medical progress. Baker dismissed the distinction between academic science and “organized science” as being based on idealized forms of inquiry. As he saw it, all scientific activity was organized in some fashion, including university research. The real and pragmatic question should be “what areas of freedom are left to them, and the nature of the

³² “Agenda: Group for Discussion of Research Administration,” January 23, 1957, Folder: “Materials from Group for Research Administration Discussion Meetings,” January 1957-May 1957, Box 12, Baker Papers.

³³ “Agenda Topic: First Year: The Nature of Science and Research in Relation to Society,” January 23, 1957. Folder: “Materials from Group for Research Administration Discussion Meetings,” January 1957-May 1957, Box 12, Baker Papers.

³⁴ “Notes on the Discussion Held,” January 23, 1957. Folder: “Material from Group for Research Administration Discussion Meetings,” January 1957-May 1957, Box 12, Baker Papers.

guidance.”³⁵ Other scientists also stressed that the “degree of freedom that the scientist requires in an organization will vary with the nature of the research.”³⁶

As one of the first and largest disease research institutions at the NIH, the NCI recognized that it had obligations to support biological and clinical research in a way to demonstrate its relevance to curing cancer.³⁷ While not a research project per se, the increasing political pressure for accelerating the development of cancer chemotherapy drugs prompted the establishment of the CCNSC in 1955. Operating under NCI director Kenneth Endicott, it aimed to coordinate the clinical trials of putative anti-cancer drugs through a system of contracts with about one hundred hospitals, many of them controlled by the Veterans Administration.³⁸ For this, the NCI in a way pioneered a goal-oriented science project, including the introduction of clinical trials and the contract mechanism for finding viable cancer drug candidates. The CCNSC’s contracts with clinical hospitals were indeed some of the earliest NIH contracts with other clinical and research organizations. It should, however, be noted that the CCNSC conducted a large-scale drug screening project, and its mode of operation resembled that of industrial organizations rather than research institutions.³⁹ As such, while it could provide a potentially useful model for managerial and financial arrangement for organized science at the NIH, its rigid and industrial mode of operations eventually turned out to be an inadequate model for organizing, managing, and planning unpredictable biomedical research at the NCI.⁴⁰

Developmental Research: Mediating between the NIH and the Public

The late 1950s and early 1960s was a time when the NIH was at a critical juncture for the future and direction of its institutional arrangement for the nation’s biomedical research. At the outset, the NIH had enjoyed enormous post-WWII growth. The majority of the NIH’s budget was given extramurally to universities, other biomedical institutions, and industry. By 1960, the DHEW had outpaced the Department of

³⁵ Ibid.

³⁶ Ibid.

³⁷ David Cantor, “Radium and the Origins of the National Cancer Institute,” in Hannaway ed., *Biomedicine in the Twentieth Century* (cit. n. 5), 95-146.

³⁸ Keating and Cambrosio, *Cancer on Trial* (cit. n. 2); and Löwy, ““Nothing More to Be Done”” (cit. n. 2).

³⁹ Bud, “Strategy in American Cancer Research” (cit. n. 2).

⁴⁰ “Virus Cancer Programs Back-up Memoranda 1963-1964,” May 15, 1964, Folder: “National Cancer Institute Research Program Supported by the Contract Mechanism,” Box 2, Baker Papers.

Defense in federal research funding for universities.⁴¹ More importantly, the introduction of the contract mechanism allowed the NIH to conduct large-scale development research, raising important managerial and fiscal questions in administering biomedical research. As the 1958 NIH report noted, “the availability of substantial research funds has made it possible to design and execute expeditiously large-scale investigations involving extensive centrally planned collaborative efforts ... particularly in such fields as clinical evaluation of drugs and epidemiological studies.” Examples of such programs in the 1950s included the case of the cancer chemotherapy program administered by the NCI, the psychopharmacology program administered by the National Institute of Mental Health, and the studies of the perinatal period administered by the National Institute of Neurological Diseases and Blindness.

The promotion of organized science through the contract mechanism raised a question about directed research. This question in turn was tied to the broader discussion of the mission of the NIH as an organization for disease problems. In 1963, at the NIH institute directors’ meeting, the following question was raised:

It appears that there is considerable difference of viewpoint regarding the mission of NIH. Some consider it to be to provide broad support for biology and medicine; others consider it to be the conduct of programs aimed at solving major disease problems of man ... Will the structure of the research apparatus of the country as presently employed in biomedical research permit us to conduct problem-solving research, if indeed more emphasis is to be placed on this in the future?⁴²

Moreover, as the NIH’s annual budget grew to more than one billion dollars a year (more than 40% of the direct support of the nation’s health research in the mid-1960s), politicians and government officials wondered whether its current organizational arrangement and operations, based largely on the mode of academic support through a system of grants, could fulfill its health and biomedical mandate for the public. President John F. Kennedy requested a qualitative evaluation of the NIH’s operation in 1963 to “judge whether the American people are getting their money’s worth from the expenditure, and to recommend any changes in organization or procedure that would ... increase the effectiveness of the program.”⁴³ Patrons of medicine like Mary Lasker and voluntary health organizations like the ACS also began to call for more goal-oriented and applicable biomedical research, asking the NIH to undertake a national program to develop novel research-based therapies or cancer

⁴¹ Elizabeth P. Berman, “Why Did Universities Start Patenting? Institution-Building and the Road to the Bayh-Dole Act,” *Social Studies of Science* 38:6 (2008), 835-871, on 844.

⁴² “Virus Cancer Programs Back-up Memoranda 1963-1964,” November 26, 1963, Folder: “Suggested Agenda Items for Institute Directors’ Meetings,” Box 2, Baker Papers.

⁴³ The White House, *Biomedical Science and Its Administration: A Study of the National Institutes of Health* (Washington, D.C.: U.S. Government Printing Office, 1965), xv.

vaccines.

The Wooldridge Committee, organized by the Office of Science and Technology at the White House, conducted an investigation. The Wooldridge Committee visited 37 institutions including universities, medical schools, hospitals, and research institutions (NIH extramural activities) and examined 52 NIH laboratories and 25 NIH contractors (NIH intramural activities). The Wooldridge Committee report concluded that the NIH needed a significant organizational effort to strengthen “its capacity for long-range planning, for determining the optimum utilization of its funds, and for ensuring that its activities and policies have the continued understanding and approval of the scientific and lay public.”⁴⁴ The report suggested the establishment of an NIH policy and planning council to bring together a group of prominent non-government scientists and laymen to participate in the major decisions of the NIH. This council in turn would assure that “the government is not, through NIH, exerting undesirable influence over the course of health-related science.”⁴⁵

As one NCI administrator admitted, “in an organization such as NIH where the dominant operation is a more passive research grants program designed to support many small uncoordinated efforts of independent investigators and institutions, it has been exceedingly difficult to obtain advice on program planning.”⁴⁶ As such, the Wooldridge Committee was critical of the NCI’s organizational deficiencies exemplified by the NCI’s cancer chemotherapy program, CCNSC. Some critics characterized it as the “nothing too stupid to test” program due to its reliance on the mass-screening of potent drug agents within the rise of standardized clinical protocols without seeking to understand proper mechanisms of drug actions.⁴⁷ The Wooldridge report noted that “it was natural that Congressional emphasis was in the direction of developmental programs aimed at specific diseases.”⁴⁸ It indicated, however, that the NCI’s adoption of the industrial mode of utilizing a system of contracts for cancer drug screening would not fit well with biomedical research, where unpredictable and unanticipated findings could often drive medical innovation.⁴⁹ The centrally organized industrial mode of cancer chemotherapy screening was designed to speed-up and optimize the evaluation of anti-cancer drugs. It was not meant to pro-

⁴⁴ Ibid., 1.

⁴⁵ Ibid., 14.

⁴⁶ Ibid., “Anonymous NCI Remarks,” 206.

⁴⁷ Jean-Paul Gaudillière, “The Molecularization of Cancer Etiology in the Postwar United States: Instruments, Politics, and Management,” in Soraya de Chadarevian and Harmke Kamminga eds., *Molecularizing Biology and Medicine: New Practices and Alliances, 1910s to 1970s* (Amsterdam: Harwood Academic Publishers, 1998), 139-170, on 158.

⁴⁸ The White House, *Biomedical Science and Its Administration* (cit. n. 43), 85.

⁴⁹ Bud, “Strategy in American Cancer Research” (cit. n. 2).

vide academic researchers with an opportunity to study new pharmacological properties of drug candidates or the biological mechanisms of their drug effects. As a result, the industry, especially pharmaceutical companies like Pfizer, Upjohn, and Bristol, took over more than two thirds of drug screening contracts by 1962.⁵⁰ The report was indeed critical of the NCI's cancer chemotherapy program, whose "design did not allow them to exploit the serendipitous nature of basic research. In this setting the collaborative programs [like CCNCS] grew rapidly but the results that have been realized are less than were anticipated."⁵¹

For the NCI as an organization for biomedical research, it would be more appropriate to find a managerial alternative to the industrial contract mechanism so that it could profitably generate and use more unanticipated but fundamental outcomes of biomedical research. The emphasis on the "public" nature of the NIH's operation and its accountability to the public, a long-held legacy of voluntary health organizations in biomedical research, provided NCI administrators with the political resources to call for a national program in biomedical research.⁵² As one NCI administrator put it, "the need of the public for more effective action in the health research field remains high and is increased."⁵³ With the growth of biomedical knowledge brought about by public support over the previous two decades, the NCI underlined that "it is now time to put the same kind and magnitude of effort into the fight against disease as we are committing to the space and atomic energy programs."⁵⁴ Two urgent and promising projects would be the viral etiology of leukemia and the investigations of cancer causation, including chemical carcinogens and smoking. This NCI memorandum, for example, acknowledged that investigations into carcinogenesis—despite their social relevance and implications for the chemical industry—were long "overdue."⁵⁵

In order to embark on focused programs in the area of cancer virology and carcinogenesis, the NCI memorandum suggested new ways in which a diverse array of academic, industrial, and political organizations could be mobilized:

the following must be done: (1) the community of biomedical scientists must be called upon within a framework of major national purpose to work in effective

⁵⁰ Peter Keating and Alberto Cambrosio note that Bud's characterization of the engineering mode of cancer chemotherapy does not account for the CCNSC's increasing flexibility to coordinate large-scale drug screening and clinical trials. See Keating and Cambrosio, *Cancer on Trial* (cit. n. 2).

⁵¹ The White House, *Biomedical Science and Its Administration*, 85.

⁵² Patel, "Methods and Management" (cit. n. 31).

⁵³ "Virus Cancer Programs Back-up Memoranda 1963-1964," July 15, 1964, 3, Folder: "A New Attack upon Disease Research Problems," Box 2, Baker Papers.

⁵⁴ *Ibid.*, 2.

⁵⁵ *Ibid.*

organization with industry with a resolve to solve major disease problems as soon as possible; (2) the people and the Congress must be willing to support this effort on a scale similar to the space programs and with comparable appropriations and authorities; (3) this program must be undertaken with the same priorities, drive and support which would be made in any serious war effort; this will require a change from the 'business as usual' attitude and will necessitate exemptions from certain ordinary regulatory and procedural barriers.⁵⁶

This brief NCI memorandum in turn underlined the contract mechanism as a way for the NCI to administer a target-oriented research program that would provide a productive bridge between basic research and tangible medical development.⁵⁷ As the NCI increasingly responded to and mobilized political pressure to develop more therapeutic drugs and medical innovations through the contract mechanism, it also tried to implement a system of contracts that would promote its collaboration with the pharmaceutical industry. For example, in 1963, Kenneth Endicott, director of the NCI, initiated changes in patent policies, modeled on the NCI's contract-supported cancer chemotherapy program. He wrote to NIH director James Shannon to ask for revisions in contract law in order to "meet the demands of fruitful integrated use of developmental research."⁵⁸ He further underlined that broader legal authority would be needed so that the NCI could initiate a financial arrangement in the use of funds for contracts to "supplement NCI high level scientific skills and to apply the body of basic research findings we have already built up by use of the special strengths that industry has, in engineering, mass production, and the management of large scale plants and pools of industrial manpower."⁵⁹

A system of contracts in turn allowed NCI administrators to take advantage of Congress's willingness to fund disease-solving research from the mid-1950s. In their pursuit of target-oriented programs in cancer virus research, NCI administrators opportunistically framed them in terms of a war against disease, calling for a new mobilization of political and scientific organizations. They embarked on cancer virus

⁵⁶ Ibid.

⁵⁷ Ibid. It listed a few exemplary organization patterns. As it indicated, "units analogous to the Virus Laboratory at the University of California at Berkeley, the Jet Propulsion Laboratory of the California Institute of Technology, or the Livermore Laboratory of the University of California can serve as the prototype organizational arrangements envisaged." Moreover, in disease categorical research, such as in the cancer research field, institutes such as the Sloan-Kettering Cancer Center and CCNSC, already established a base pattern with industrial collaboration that could "provide the appropriate framework for some types of research and development effort," p. 2.

⁵⁸ Kenneth Endicott to James Shannon (NIH director), "Applied Developmental Research and Research Services – Need for Legislation," February 28, 1963, Folder: 1963, Box 2 ("Virus Cancer Programs Back-up Memoranda 1963-1964"), Baker Papers.

⁵⁹ Ibid.

research through a system of contracts between the late 1950s and early 1960s, establishing a series of task force groups related to leukemia virus research and research infrastructure. As Figure 2 shows, the NCI's appropriations for contract funds increased dramatically from 1955, overshadowing the NCI's grant funds by 1965.

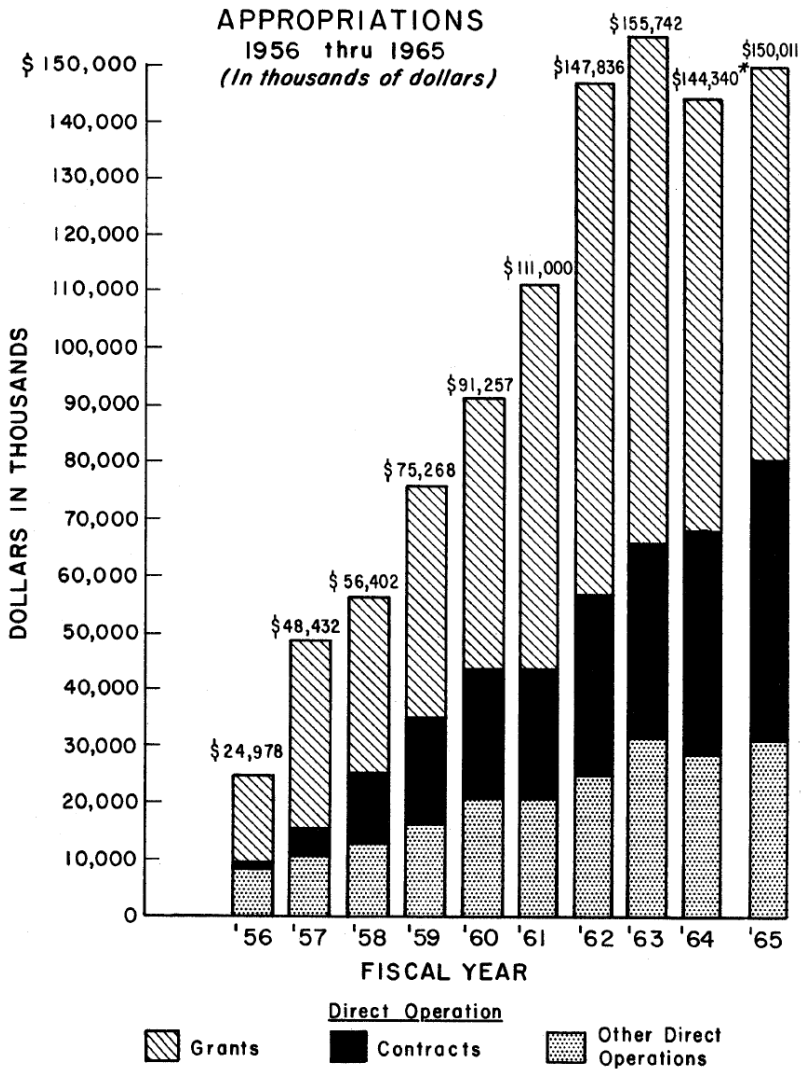
More importantly, the increased use of the contract mechanism was tied to the NCI's promotion of "developmental research" as a new kind of research that would be responsive to the public's call for medical breakthroughs. In the early 1960s, the NCI claimed that in certain areas of research, targeted contract research was needed in order to accelerate the development of laboratory-based cancer therapy. NCI director Endicott, with the help of NIH director James Shannon, prepared the so-called *Ruina Report* to articulate the political and scientific legitimacy of developmental research at the NIH.⁶⁰ The report claimed that to make fuller use of basic biomedical research findings supported by taxpayer money, it needed further organizational innovations to translate basic research into medical and pharmaceutical developments:

Biomedical research is now yielding, with increasing frequency, results which promise major benefits in health and longevity, but which call for large-scale *directed* research or for *development* before they can be put into use. The National Institutes of Health, which in the past two decades has selected and supported, in major part, the research leading to these promising opportunities, now faces the problem of exploiting them ... New methods of organization and procedures may be needed.⁶¹

NCI administrators noted that post-WWII government support of biomedical research through a system of grants over the previous two decades had created a large reservoir of biomedical knowledge. Therefore, NCI administrators suggested that the time was ripe for implementing a major attack on disease problems by mobilizing biomedical research and development in an organized manner. However, NCI administrators noted, academic scientists were not particularly interested in this so-called developmental research, and the pharmaceutical industry was rather hesitant to adopt new, uncertain basic findings in biomedical research. By taking an initiative to invest in developmental research that could link basic research to therapeutic development, the NCI claimed that it could fulfill its obligation to the public's demand for the promotion of health.

⁶⁰ U.S. Department of Health, Education, and Welfare, Office of the Secretary, *Report of the Secretary's Advisory Committee on the Management of NIH Research Contracts and Grants*, (Washington D. C.: U. S. Government Printing Office, 1966), hereafter referred to as the *Ruina Report*.

⁶¹ *Ibid.*, 2. Emphasis in original.



*\$14,600,000 for Cancer Control now appropriated elsewhere.

11/64

National Cancer Institute

Figure 2. NCI Appropriations/Budgets, 1956-1965. National Cancer Institute, *NCI Factbook* (Published by NCI, 1964), 6, from NCI Lion Database. The first contract at the NCI was granted for the CCNSC in 1955, and then the use of the contract mechanism expanded to include cancer virus research in the 1960s.

At another level, NCI staff noted that the need for the coordination and management of a goal-oriented project was imperative given the disciplinary and institutional diversity in biomedical research. Not only did biomedical disciplines vary widely, so did the site of their practice, which ranged from universities to government and industrial laboratories. In this context, assembling and directing the diverse biomedical complex under a new framework to work on disease problems seemed to require new organizational arrangements. NCI administrators in turn maintained that developmental research, unlike basic research where unknown findings were brought about, could be planned, programmed, and managed in advance. Baker, who became an assistant to NCI director Endicott and later interim NCI director in 1969, led this new managerial experiment for cancer virus research.

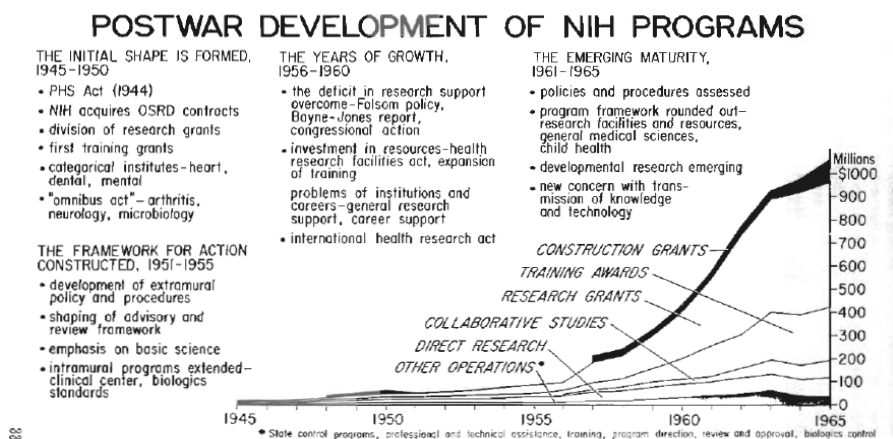


Figure 3. The Emergence of Developmental Research at NIH, in the column “The Emerging Maturity 1961-65,” *Ruina Report* (1966). It underscored the emergence of developmental research as a new program that would take advantage of new biomedical research findings supported by the NIH.

The Special Virus Leukemia Program

A group of research administrators at the NCI, led by Baker, tried to find concrete ways to implement orchestrated, goal-oriented research projects. Baker, an active participant in the NIH’s Research Administration Discussion Group, agreed with NCI director Endicott that the current NIH operation was inadequate to organize biomedical research into a goal-oriented program. They tried to adopt administrative and managerial techniques from other federal agencies like the AEC and NASA.

These federal agencies developed so-called systems analysis, which utilized a set of mathematical techniques and computers in order to optimize the production of large-scale weapons and engineering systems, such as the atomic bomb and spaceships.⁶² In 1961, Endicott appointed Baker associate director for the program responsible for overseeing research planning at the NCI. Baker hired Louis Carrese, an industrial sociologist, in order to develop research management and planning techniques for the coordination of a large-scale biomedical research project.⁶³ During the early 1960s, he took a course in systems analysis offered by the private company Honeywell in order to learn how to manage a large-scale, goal-oriented research and development project. The course, titled “Introductory Systems Analysis” covered material regarding systems analysis and electronic data processing (EDP).⁶⁴

Soon Baker and Carrese created an introductory course on systems analysis for research planning and programming at the NIH. The course taught NIH research administrators how to adopt systems analysis and EDP for the administration of biomedical research, using computers and other database processing. During this course, Baker and Carrese realized that systems analysis was not fit for basic biomedical research, where unexpected findings would radically change investigate pathways for development. Systems analysis was originally developed for large-scale engineering projects in defense and aerospace programs. In those engineering projects, the basic knowledge necessary for the development of atomic bombs and space crafts was largely known. However, Baker and Carrese emphasized that most of the basic biomedical knowledge necessary to find a cure for cancer was not well known. So the program for developing a cure for cancer should accommodate unanticipated experimental findings for future research planning and adjusting. As Baker later noted, “systems of network for planning and operating a *research* program required modification.”⁶⁵

Baker and Carrese soon developed a modified version of systems planning under the name of the “convergence technique,” which aimed to make hundreds of scientific projects “converge” toward a single purpose in a highly organized way.⁶⁶ It was

⁶² Michael Fortun and Sylvan S. Schweber, “Scientists and the Legacy of World War II: The Case of Operations Research,” *Social Studies of Science* 23:4 (1993), 595-642.

⁶³ Carl G. Baker, *An Administrative History of the National Cancer Institute’s Viruses and Cancer Program, 1950-1972* (Bethesda: Office of NIH History, 2004), 43.

⁶⁴ Folder: “Materials from Group for Research Administration Discussion Meetings, Introductory Systems Analysis,” November 26-30, 1962, Instructor, Miss Ethlyn Brooks (Systems Service Representative, Minneapolis-Honeywell), and Participants, Carl Baker and Louis M. Carrese, Baker Papers.

⁶⁵ Baker, *An Administrative History*, 126. Emphasis in original.

⁶⁶ Their convergence technique was later published as Louis M. Carrese and Carl G. Baker, “The Convergence Technique: A Method for the Planning and Programming of Research Efforts,”

basically an adaptation of the systems and network approaches that had been designed for the scheduling, control, and costing of large-scale engineering production problems that led to the atomic bomb and spaceships. The convergence technique was intended to “optimize” the performance of the goal-oriented system, which consisted of numerous system components and networks or “flows” that would connect the system as a whole. Applied to biomedical research, the convergence technique designed a set of a “linear array” of scientific projects, which would advance scientific goals, such as identifying cancer-causing viral agents, the production of cancer viruses for research and development, and the completion of developmental work for the production of cancer vaccines. The “flows” of research, resources, and information through the networks of coordinated research programs would advance each array of research projects (see Figure 4).



Figure 4. Carl Baker (Left), Director of the NCI, 1970-1972, with Louis Carrese (Center), and Frank J. Rauscher, Jr. (Right), Behind them is a Flow Chart for the Special Virus Leukemia Virus. NCI Database Lion, Public Domain.

The distinctive feature of the convergence technique was that it was developed

Management Science 13:8 (1967), 420-438. For a broad introduction to systems analysis in the federal and state governments as a Cold War-type technology, see Jennifer S. Light, *From Warfare to Welfare: Defense Intellectuals and Urban Problems in Cold War America* (Baltimore: Johns Hopkins University Press, 2003); and Schaffler, “Managing the Future” (cit. n. 4).

“specifically for research efforts.” As scientific research inevitably entailed uncertainty, NCI research administrators would need to access research flows at “monitoring and decision” points, adjusting an array of linear scientific projects toward a defined goal in the light of any unexpected findings. With each successful completion of a scientific project, for example, the so-called scientific managers would “(a) negate the underlying assumption(s) upon which the work was based; (b) affirm the underlying assumption(s) of the work . . . ; or (c) neither negate nor confirm but open up several additional lines of research which should be pursued.”⁶⁷ In this way, the convergence technique allowed research administrators to flexibly implement research planning that would mobilize a diverse array of biomedical researchers and institutions.

The first application of the convergence technique was to the field of cancer virus research. As Scheffler convincingly argues, a public call for conquering childhood disease, especially polio and leukemia, provided the political resources for accelerating leukemia virus research.⁶⁸ NCI director Endicott in turn mobilized the call for a cure for childhood cancer, aggressively promoting large-scale, goal-oriented research. He sought independent funding directly from Congress, arguing that the government agency should “purchase” necessary biomedical research for curing childhood cancer, acute lymphocytic leukemia. In 1958, the NCI directly requested \$1 million in special appropriations from Congress. The NCI noted that recent developments in the intersection of virology and cancer research provided an especially promising research direction.⁶⁹ More importantly, NCI scientists had begun to establish that viruses were the causative agents for certain leukemias in chickens, mice, and rats from the late 1950s. Ludwik Gross at the Bronx Veterans Administration Hospital and Sarah Stewart at the NCI demonstrated the viral origins of cancer in mouse leukemia.⁷⁰ After Gross’s isolation of the mouse leukemia virus, Lloyd W. Law of the NCI showed the viral causation of many tumors in mice. In the early

⁶⁷ Carrese and Baker, “The Convergence Technique,” 421.

⁶⁸ Scheffler, “Managing the Future” (cit. n. 4).

⁶⁹ For a history of tumor virology in the twentieth century, see Daniel J. Kevles, “Renato Dulbecco and the New Animal Virology: Medicine, Methods, and Molecules,” *Journal of the History of Biology* 26:3 (1993), 409–442; Idem., “Pursuing the Unpopular: A History of Courage, Viruses, and Cancer,” in Robert B. Silvers ed., *Hidden Histories of Science* (New York: New York Review of Books, 1995), 69–114; Doogab Yi, “Cancer, Viruses, and Mass Migration: Paul Berg’s Venture into Eukaryotic Biology and the Advent of Recombinant DNA Research and Technology, 1967–1980,” *Journal of the History of Biology* 41:4 (2008), 589–636; and Scheffler, “Managing the Future” (cit. n. 4).

⁷⁰ Ludwik Gross, “Spontaneous Leukemia Developing in C3H Mice Following Inoculation, in Infancy, with AK-Leukemia Extracts, or AK-Embryos,” *Proceedings of the Society of Experimental Biology and Medicine* 76 (1951), 27–32.

1960s, a few significant tumor viruses, such as the Moloney virus (1960) and Rauscher virus (1962), were discovered at the NCI.⁷¹

Indeed, by the late 1950s and early 1960s, the biomedical research community began to pay attention to cancer virus research. After the development of polio vaccines, investigators of polio began to shift their research into animal cancer viruses. The NCI began to support polio researchers such as Albert Sabin and Joseph Melnick in the application of their research expertise in virology to cancer problems. In 1958, scientists developed a tissue culture technique to grow the mouse polyomavirus. It was a significant breakthrough in animal virus research, since there had been no feasible ways to grow and isolate animal viruses in mass quantity. The ability to produce tumor-inducing animal viruses in large quantities could provide significant research material and infrastructure that could further cancer virus research. Just as polio researchers made productive use of tissue culture systems for the isolation of polio viruses, some scientists expected that the proper development of tissue culture could further cancer virus research. If scientists could identify and isolate a virus that could induce cancer in animal cells, then they could attenuate the virus for the development of a cancer vaccine. Harry Eagle, the NCI's first scientific director, modified tissue culture procedures and developed media that could be prepared and distributed on a commercial basis. As one NCI scientist put it, the prospect of a cancer vaccine, just after the polio success, "swept the biomedical research community like a prairie fire."⁷²

With the 1958 special congressional appropriation, the National Advisory Cancer Council established the Virus and Cancer Panel (VCP) at the NCI in February 1959 in order to promote virus cancer research. The VCP initially encouraged individual investigators with a polio research background to apply for research funding for cancer virus research. More importantly, it also tried to coordinate viral oncology research efforts through a system of contracts. As Baker later notes, "contracts, integrated into the systems plan, became the major tool for implementing the program."⁷³ The NCI, adopting the convergence technique for systems planning for cancer virus research, noted that the slow development of cell culture technologies in animal virology was one of the major impediments in the study of tumor-inducing viruses. Until the late 1950s, scientists were able to grow only a few animal viruses. The areas of research technologies and infrastructure, however, were not a major

⁷¹ Sarah Stewart, B. E. Eddy, and N. Borgese, "Neoplasms in Mice Inoculated with a Tumor Agent Carried in Tissue Culture," *Journal of the National Cancer Institute* 20:6 (1958), 1223-1243; and John B. Moloney, "Preliminary Studies on a Mouse Lymphoid Leukemia Virus Extracted from Sarcoma 37," *Proceedings of the American Association for Cancer Research* 3 (1959), 44.

⁷² Report Draft Sent to the Woodridge Committee, "Collaborative Program: NCI Virus Cancer Program." Folder: 1964, Box 2, Baker Papers.

⁷³ Baker, *An Administrative History* (cit. n. 63), 6.

focus of research scientists. Moreover, it required substantial investment to build up the necessary research infrastructure in animal cell culture.⁷⁴

The NCI decided to use a system of contracts for the development of cell culture infrastructure as a way to provide an essential research technology for virologists in the early 1960s. The NCI adopted the contract mechanism so that it could manage the Virology Research Resources Branch (VRRB) to produce research materials necessary for virological work in mass quantity. It was an attempt to build a research infrastructure that could help biomedical researchers shift their research into the molecular biology of cancer. A group of NCI administrators in turn discussed possible contractors in the private and public sector. Small biochemical and big pharmaceutical companies, such as Microbiological Associates, Pfizer, Bionetics, and government laboratories at the Oak Ridge National Laboratory operated by the Atomic Energy Commission (AEC)-Union Carbide, and academic institutions like Pennsylvania State University, the University of Pennsylvania, and Michigan State University were considered as potential contractors.

In addition to the development of research infrastructure for animal virology, the VCP assembled a cadre of virologists in its intramural program to oversee its coordinated research project. In 1961, the NCI established the Laboratory of Viral Oncology in its intramural programs with Ray Bryan as Chief. Other prominent investigators, such as Frank Rauscher, Jack Dalton, John Maloney, Sarah Stewart, Mary Fink, Guy de Thé, and Robert Manaker, joined. In early October 1962, the NCI organized the Human Cancer Virus Task Force. W. Ray Bryan was appointed as its Chairman, and scientists at both the NIH and academic institutions were appointed as members of the Human Cancer Virus Task Force, such as James Grace and Frank Horsfall from the Rockefeller Institute in New York, Joseph Melnick from Baylor University, NCI administrators Paul Kotin and Robert Miller, Robert Stevenson, and Robert Huebner at the NIAID. These scientists formed the administrative core for the management of the coordinated, goal-oriented developmental research program that evolved from the Acute Leukemia Task Force in 1962 to the SVLP in 1964.⁷⁵

The SVLP, as its “Special” designation suggested, was a developmental research program that would utilize a system of contracts for conducting goal-oriented research projects in order to help develop a leukemia virus vaccine. While the NCI

⁷⁴ For the history of animal tissue culture, see Hannah Landecker, *Culturing Life: How Cells Became Technologies* (Cambridge, MA: Harvard University Press, 2007). For the significance of research infrastructure in biomedical research, see Angela N. H. Creager and Hannah Landecker, “Technical Matters: Method, Knowledge, and Infrastructure in Twentieth-Century Life Science,” *Nature Methodology* 6:10 (2009), 701-705.

⁷⁵ Frank J. Rauscher, Jr. and Michael B. Shimkin, “Viral Oncology,” in DeWitt Stetten, Jr. and W. T. Carrigan, eds., *NIH: An Account of Research in Its Laboratories and Clinics* (New York: Academic Press, 1984), 350-367.

usually supported basic research through the grant mechanism, the SVLP was initiated under a specific mandate by Congress to use the contract mechanism for the structural study on tumor viruses and vaccine production. The SVLP utilized the convergence technique, mapping out the logical sequences (“linear arrays”) that leukemia virus research and development should take in accordance with “flows” of research, resources, and information (see Figure 5). This whole set of coordinated programs was proposed by NCI administrators and scientists, such as Baker, Carrese, and a young NCI cancer virologist Frank Rauscher. They first sought a special Congressional appropriation of \$20 million per year. This “special” program, with its adoption of systems planning and the contract mechanism, aimed to contribute to the expeditious development of significant scientific results generated by taxpayer support to the benefit of the public. In this sense, it was supplementary to existing research regarding cancer viruses, and a means of integrating all cancer virus-related research for the development of a cancer vaccine.

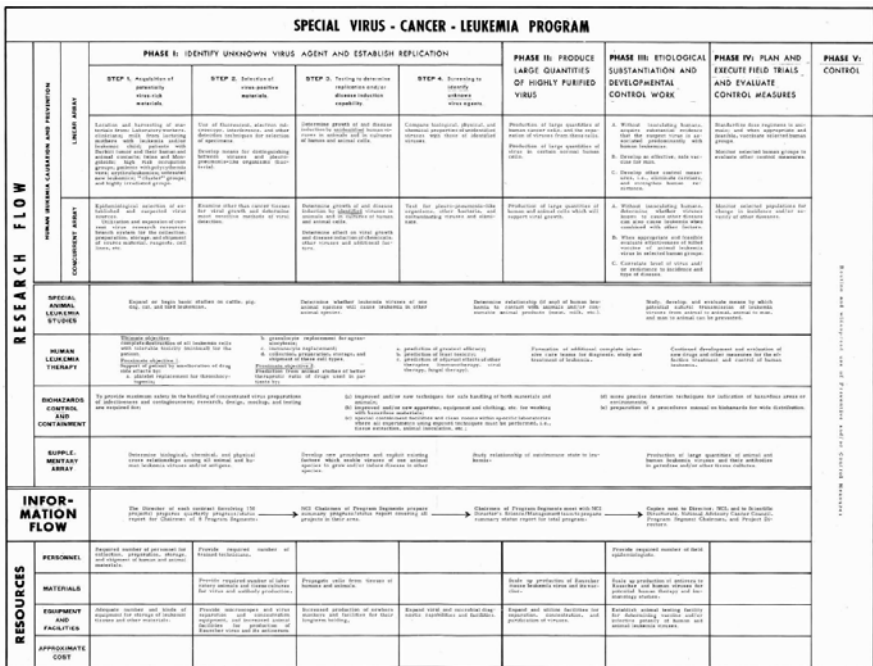


Figure 5. A Flow Chart for the Special Virus Leukemia Program, October 1964, NCI Lion Database, Historical File, No AR Identification Number. This flow chart aimed to guide the SVLP. It divided research areas along horizontal lines, such as human leukemia causation and prevention, animal leukemia studies, human leukemia therapy, and biohazards control and containment. Vertical columns, or linear arrays, indicated where each research project should be in a relation to the other projects. The whole program was staged into five phases, which aimed to discover a human cancer virus and then to develop a cancer vaccine.

ACTIVITY	LEUKEMIA/LYMPHOMA							MEASLES
	AVIAN	MURINE	FELINE	CANINE	BOVINE	AMPHIB.	MAN	POLIO
ACQUISITION OF MATERIALS	1893	1953	1962	1965	1960	1965	1957	1930
DETECTION								
ISOLATION								
REPLICATION						"H"	"C"	
IDENTIFICATION								
CHARACTERIZATION								
INDUSTRIAL REPLICATION							"H"	
CONTROL								
ANIMAL:	AVIAN	MURINE	FELINE	CANINE	BOVINE	AMPHIB.	MAN	MAN
YEARS:	> 73	10	> 4	> 1	> 6	> 1	> 9/ 2	58 34
NO. "VIRUSES":	3	16	1	-	-	-	-	3 1
DISEASE CONTROL:	None	Vaccine Genetic Therapy Fomite	None	None	Sacrifice	None	Therapy	Vaccine

Figure 6. Special Virus Leukemia Program Progress Report, May 1966, NCI Lion Database, AR-6605-001594, 9. The dotted lines in the human leukemia viruses column indicated that at least one kind of human leukemia virus could be found in the near future.

Congress granted \$10 million for the establishment of the SVLP in 1964, and its budget grew rapidly over the years. Its plan was to identify potential viral agents of leukemia, and then develop a vaccine for leukemia. The SVLP was a new style of biomedical research that would coordinate rapid developments in basic research programs and developmental work within the framework of a specific, defined goal. In 1966, a *Life* Magazine article lauded the SVLP as “A Superplan to Cut Years off the War” against cancer. The article even claimed that the SVLP’s flow chart would “revolutionize medical research ... and enormously accelerate[s] research progress.”⁷⁶ During the 1960s, many scientists found some viruses induced or at least associated in tumorigenesis in mice and other animals, such as frogs, cats, dogs, and cattle. As it began to be believed that man might not be an exception to this viral origin of cancer, the support for cancer virus research, especially for the SVLP, increased. As Figure 6 shows, the SVLP hoped to translate the findings on other animals to man so that it could develop a cancer vaccine, as scientists previously had identified polio and measles for the development of vaccines against them.

The establishment of the SVLP as organized science in 1964 signaled a new relationship between the federal government, the public, and the biomedical research

⁷⁶ Albert Rosenfeld, “A Superplan to Cut Years off the War,” *Life* (18 November 1966), 108.

community. Now the NCI, empowered by public calls for medical progress, initiated one of the first experiments in research management at the NCI for developmental research. It utilized new technologies of research management and financed research through a system of contracts for translating the public's call to conquer cancer into coordinated, goal-oriented programs. By assessing overall progress in the field of tumor virology, the SVLP tried to identify new scientific opportunities and adjust its research planning. In addition, the SVLP, through the contract mechanism, orchestrated overall research support by providing the managerial resources necessary for organizational rearrangements, such as managing contract reviews. The SVLP indeed firmly established a new style of the biomedical enterprise with definite planning for the development of medical products. Indeed, when the Nixon Administration embarked on planning a national campaign against cancer, the managerial, organizational, and financial model of the SVLP became a guide for Nixon's War on Cancer.⁷⁷

Conclusions

This paper has provided an institutional and political background for the emergence of organized science at the NCI in the 1950s and 1960s. First, the biomedical mandate of the NIH and its accountability to the public at large led to discussions about the nature and mission of the NIH as a disease-categorical research organization. In many ways, a political dynamic between the federal government, the biomedical research community, and the public after WWII played a critical role in shaping the NCI's organizational and managerial innovations. Indeed, a series of policy reports on the administration of biomedical research and implications for the public's expectations of medical progress in turn provided NCI research administrators, such as Endicott and Baker, with an opportunity to articulate the concept of developmental research, one that could be organized, managed, and planned.

With their zeal for organized science and research planning, NCI administrators appealed directly to Congress, opening a way for the advent of the SVLP as a target-oriented biomedical project. A group of research administrators and biologists at the NCI conceived a virus cancer research program as an experiment in research management and planning: most notably, it adopted a system of contracts in research support and systems analysis techniques in research planning. Baker and Carrese in turn developed convergence technology as a management technology for administering developmental research. With scientists' intervention in research flows at

⁷⁷ Nicholas N. Wade, "Special Virus Cancer Program: Travails of a Biological Moonshot," *Science* 174 (1971), 1306-1311.

monitoring and decision points within the framework of a goal-oriented research system, they argued that they could maintain managerial and scientific flexibility. Thus through the SVLP, they claimed, the contract mechanism and systems planning could be fruitfully mobilized, even when critical knowledge on virus leukemia was not yet known, to direct a research goal. Inspired by a call to conquer childhood leukemia, Congress in turn financed the NCI's intensified research on the viral origin of leukemia.

This paper in particular highlights the fiscal social history of the SVLP as a way of illustrating how the increasing uses of the contract mechanism for cancer virus research emerged within the context of the nation's shifting biomedical administration and research policy. As Bell noted in his brief examination of the fiscal history of the U.S. federal government, the 1960s saw the enormous growth of social and welfare related federal spending. A series of calls for directed and target-oriented research during the 1960s, along with special congressional appropriations, encouraged the federal government and the NCI to "purchase" goal-oriented research and technical solutions. More importantly, the development of research managerial technologies and the adoption of a system of contracts for financing and guiding cancer research enabled NCI administrators and scientists to translate the public's demand for a cancer cure into a developmental research project, one that could link basic biomedical research to medical and pharmaceutical development.

Subsequently, the NCI's SVLP increasingly used the contract arrangement with academic, industrial, and semi-industrial companies in order to implement large-scale, goal-oriented biomedical research projects. In 1968, the SVLP expanded to the Special Virus Cancer Program (SVCP), encompassing all types of cancer viruses. By the early 1970s, the SVCP emerged as a national program of targeted, managerially guided research on viral oncology: the virus cancer program gained a top-priority position at the NCI, managing 88 contracts as of 1970. As the SVCP became a key part of the National Cancer Plan of 1971, it became one of the most visible and controversial programs in the Nixon administration's "War on Cancer" plan.⁷⁸ Indeed, President Richard Nixon appointed Frank Rauscher, the leader of the SVCP, as the director of the newly empowered NCI in 1972. With its unusual style of implementing target-oriented biomedical research, the SVCP emerged as a viable model for mediating between the government, the biomedical research community, and the public during the War on Cancer in the 1970s.

⁷⁸ Rettig, *Cancer Crusade* (cit. n. 9).

Abstract

This paper examines the fiscal, managerial, and institutional history of the Special Virus Leukemia Program (SVLP) at the National Cancer Institute (NCI) of the U.S. National Institutes of Health (NIH) in the 1950s and 1960s. It first investigates the discussions about the nature and mission of the NIH as a research organization in order to provide the broader institutional and political context for the emergence of developmental research as an exemplary organized science. This paper then analyzes how NCI administrators tried to articulate “developmental research” as a particular style of biomedical research that could mediate the government’s obligation, scientists’ creative needs, and the public’s call for medical progress. In turn, NCI administrators and scientists, such as Carl Becker, Louis Carrese, and Frank Rauscher, developed and mobilized distinctive financing and management techniques for the SVLP, such as the contract mechanism and the convergence technique. Their efforts to institute the SVLP as an exemplary organized science that could be planned, programmed, and managed enabled them to translate the public’s demand for a cancer cure into a developmental research project, one that could link basic biomedical research to medical and pharmaceutical development. The SVLP in turn left a fiscal, managerial, and organizational legacy for the subsequent evolution of large-scale, goal-oriented developmental research projects in cancer from the 1970s, as exemplified by Nixon’s War on Cancer.

Keywords: cancer, organized science, developmental research, research policy & management, contract mechanism, fiscal history, National Cancer Institute