Chapter II
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Demonstrations as an explicit policy instrument have emerged from two distinct traditions. They have evolved, first, within the context of the Federal Government's support of R&D and, second, in the context of the Federal social action programs of the 1960's. It is both appropriate and useful, therefore, to sketch the origins of demonstrations in these two traditions so that we can better understand their contemporary manifestations. And because the R&D tradition is older, broader, deeper, and the source of much of our thinking about demonstrations. it will receive somewhat greater emphasis than the social action tradition.

The R&D Tradition

The Federal Government currently supports R&D for a number of purposes at an annual level of *$23* billion. Historically, six major patterns of support can be identified, each of which is discussed briefly below. These patterns are agriculture, national security, basic and applied research, domestic public policy, regulation, and energy. (Though agriculture and energy are logically subordinate to domestic policy, they are historically distinct and of sufficient importance to warrant separate consideration.) An analysis of these six patterns can reveal important similarities and differences in the purposes for which the Federal Government has supported R&D. Because demonstrations have been justified mainly within the context of Federal R&D programs, then, an understanding of these patterns can contribute to an understanding of demonstrations.

Agriculture

Agriculture is often regarded as possessing a comprehensive system for generating practical research results and transmitting them into application. This "system" includes a highly differentiated research establishment, supporting activities from basic research through development in State, regional, and National laboratories. It also includes educational programs, located mainly at State land-grant colleges, which provide training for the next generation of farmers and agricultural scientists and continuing education for agricultural producers, processors, and even consumers. In the State experiment stations, the system has the capacity to test promising new research results on the appropriate scale as well as exemplify the utility of validated results. Through the extension service and a variety of other communication channels, the agricultural system has the means for transmitting valuable new information from the research establishment to agricultural producers, processors, and consumers.

Several factors should be kept in mind concerning the agricultural system. [1] First, as with many of the other policy areas we will discuss, the development of Federal R&D policy was accompanied by fundamental political conflict. There was no formally sanctioned Federal role in agriculture until the 1860's. The Southern States, guided by the doctrine of States rights, successfully opposed creation of a Federal Department of Agriculture and a federally supported system of agricultural schools prior to the Civil War. This constitutional controversy was resolved only when the South seceded from the Union. The massive realignment of political power and reorientation of political philosophy that then occurred in Congress resulted in significant new legislation in 1862: a Department of Agriculture was established, the Merrill Act authorized land-grant colleges of "agriculture and mechanical arts, " and the Homestead Act opened the lands of the West.[2]

Within a sanctioned Federal role in agriculture,

'The primary source for this section is A. Hunter J1.pee, Science in the Federal Government, Harvard University Press, Cambridge, Mass., 1957, PP. 109-114. 149-183, 348-350 et passim.

'Ibid, pp. 149-151.

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a second consideration is that the system of research, education, experimentation, and extension developed slowly. The Federal Department itself went through a slow process of development which rejected a scientific discipline-oriented pattern of research organization in favor of an agricultural problem focus.[3] There was a concurrent, but also lengthy, development of State experiment stations in conjunction with the land-grant colleges, but Federal funding and Federal efforts at coordination took 25 years to develop. The extension service, moreover, was not authorized by Federal statute until 1914. Regional laboratories, and the national Beltsville laboratory, came even later. That a system that evolved over at least three generations has not been readily duplicated by others should not be surprising.

Several other points are noteworthy for this discussion. The institutional framework that developed in agriculture was much more the product of politicians and practical men than of scientists.' The framework itself, however, did not dictate results and the "validation" of the system came only as scientific results in entomology, animal diseases, and botany began to show practical results of the 1880's and 1890's. In this context, the experiment station provided the logical site for the "demonstrations" of the day: laboratory results that appeared promising could be "proved" in the agricultural setting, and validated results could be demonstrated to skeptical farmers.

National Defense

The major share of Federal R&D in the post-World War 11 period has been for national security purposes. Most of the national security R&D has been funded by the Department of Defense (DOD), though the Atomic Energy Commission (AEC) and its successor agencies have provided funds for R&D on nuclear warhead development. Furthermore, the creation of the National Aeronautics and Space Administration (NASA) in 1958 and the rationale for the Apollo-manned lunar exploration mission in the 1960's can be attributed to the international threat from the space program of the Union of Soviet Socialist Republics.

The role of the Federal Government in national security has never been an issue, inasmuch as "the common defense" is a central part of the Constitution. Defense-related R&D, therefore, has evolved as an integral component of DOD and the uniformed services. It has been supported for the purposes of providing and maintaining a technologically advanced military capability, generating technical options for the future, and hedging against technological surprise by international adversaries.

Demonstrations per se do not constitute part of the vocabulary of defense R&D. On the other hand, certain R&D activities can be identified in the defense context as quite similar to demonstrations as defined in this report. These include testing a complex weapons system (usually at the prototype stage) at the level of systems integration of a number of established component technologies in a simulation of a real-world operational environment; and conducting competition among prototype weapons systems for the purpose of choosing the preferred system. These activities have their analogues in the policy-implementing and policy-formulating demonstrations discussed below.

The distinguishing characteristic of defense R&D is that a strong relationship exists between the R&D investment and the incorporation of the results of that investment in advanced weapons systems and component technologies. In institutional terms, a single, integrated organizational system is both responsible for generating new military technology and for purchasing such technology. It should be emphasized, though, that the search for the appropriate organizational arrangements to relate R&D, weapons systems procurement, and force posture needs has been a long and complicated one in the three decades since World War 11.[5] As complex as this institutional system is, it remains simple in the fundamental relationships that govern organizations

[3] This development alone took several decades (ibid., pp. 157-169)

'The deep involvement of the States through the land-grant colleges and the experiment stations practically insured attention to the system by political officials (see ibid., PP. 169-176 et passim).

[5] A useful overview of the institutional evolution of defense R&D is presented in Herbert F. York and G. Allen Greb, "Military Research and Development: A Postwar History," Bulletin of the Atomic Scientists, Vol. 33, No. 1, January 1977, pp. 13-26. York was the first Director of Defense Research and Engineering.

within it. Defense R&D and the equivalent of demonstrations within the R&D context, therefore, are characterized by strong relationships between R&D inputs and defense products and by a fundamentally integrated, and relatively simple, institutional system.

Basic and Applied Research

World War 11 had a powerful "demonstration effect" on conceptions of the Federal Government's role in R&D. [b] Basic research became recognized as a critical contributing factor to major technological advance. The connection was most obvious between nuclear physics and nuclear fission, but was also dramatically illustrated in the case of penicillin. Consequently, in the postwar era, several Federal agencies developed with the support of basic research as a primary mission.

The policy rationale for this basic research was largely utilitarian (science for its applications) with a strong aesthetic component (science for its own sake). The rationale that emerged as welfare economists turned their attention to the area was that basic research generated "external benefits" that could not be fully captured by the sponsor. [7] This led to an assumption that systematic underinvestment in basic research by the private sector would occur relative to the socially optimal level of support and then to an a priori justification for Government support of basic research. This argument was extended to include applied research whose results were not easily appropriable by private firms for commercial application. The theoretical limit on the Government's R&D activity was thus defined by appropriability of results: it was inappropriate for the Federal Government to fund work appropriable by the private sector, since firms could be expected to finance such R&D themselves. The operational limit on Government's R&D activity was essentially set by drawing a boundary between applied research and development. [a] In this context, the question of demonstrations did not arise because application of R&D results was left to the private sector.

Domestic Public Policy

The Federal Government supports R&D in a number of areas of domestic policy. Many of these R&D efforts include demonstrations.

The area of health and medicine, however, differs from many other policy areas in notable ways. First, the rationale for Federal Government support of medical research, largely through the National Institutes of Health (NIH), is a product of several factors—the successful applications of medical research results in World War 11 (e. g., penicillin, antimalarial drugs, treatment of burn and trauma),9 the limited resources of private philanthropy in sustaining an expanding medical research enterprise after the war, 10 the lack of interest by the pharmaceutical industry in supporting fundamental research, and the lack of opposition by organized medicine. [11] Second, because the main element of NIH strategy over the years has been to invest proportionately more in fundamental research than in applied or clinical research, interest in demonstrations has been relatively weak.[12] Third, in response to

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'See, for example, J. Merton England, "Dr. Bush Writes a Report: 'Science—The Endless Frontier, ' " Science. Vol. 191, Jan. 9, 1976, pp. 41-47, and Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942-1945: A Political Interpretation of 'Science—The Endless Frontier,' " 1S1S, Vol. 68, No. 241, 1977, pp. 4-26.

'See Richard R. Nelson, "The Economics of Invention: A Survey of the Literature, " Journal of Business Vol. XXXII, No. 2, April 1959, pp. 101-127, and Kennetb J. Arrow, "Economic Welfare and the Allocation of Resources for Invention, " in Richard R, Nelson (ed,), The Rate and Direction of Inuentiue Activity: Economic and Social Factors, a Report of the National Bureau of Economic Research, Princeton University Press, Princeton, N. J., 1962, pp 609-626,

'See Richard R. Nelson, Merton J. Peck, and Edward D. Kalachek,Technology, Economic Growth, and Public Policy, The Brookings Institution, Washington. D. C.. 1967, pp. 171-211 et passim; George Eads and Richard R. Nelson, "Governmental Support of Advanced Civilian Technology—power Reactors and the Supersonic Transport, " public Policy, Vol. 19, 1971, pp. 405-427. and George Eads, "U.S. Support for Civilian Technology Economic Theory and Political Practice," Research Policy, Vol. 3, 1974, pp. 2-16.

[9]See E.C. Andrus et al. (eds.), Aduances in Military Medicine, Vols. 1 and II, Little, Brown and Company, Boston, Mass., 1948.

[10]See England op. cit., p. 44.

[*]'See American Medical Association, Report *of the Commission* on Medical Research, Chicago, Ill., 1967.

[12]A very useful historical overview is presented in Stephen P Strickland, *Politics, Science,* and *Dread* Disease: A *Short* History *of* United States *Medical* Research Policy, Harvard University Press, Cambridge, Mass., 1972.

more recent pressures to concern itself with the application of medical research results, NIH has supported an increasing number of controlled clinical trials. These trials emphasize the validation of research results in the clinical setting rather than promotion of widespread use of such results, and are thus analogous to demonstrations intended to prove a technology. There are cancer and heart-disease control programs, on the other hand, that are more analogous to exemplification demonstrations. These control programs, however, coexist rather uneasily with the more rigorous research-oriented activities of NIH.

In the mid-1960's, Federal Government R&D resources were increasingly allocated to a number of domestic policy areas—urban mass transit, postal services, housing and urban affairs, education, manpower, and law enforcement and criminal justice. The R&D efforts in these areas took place as two large secular shifts, sometimes overlapping, occurred. One was that the importance of the public sector increased relative to the private sector as, for example, in urban mass transit. The other was that the importance of the Federal Government increased relative to State and local government. In some policy areas, an expanded Federal role paved the way for greater Federal R&D, e.g., education; in others R&D constituted the "entering wedge" for an expanded Federal role, e.g., criminal justice.

These domestic policy areas have two characteristics of consequence for demonstrations. On the one hand, the scientific understanding of central phenomena and the technical base undergirding operational activity are not well developed, thus the contribution of R&D is often problematic. At the same time, the institutional environment in these areas is highly complex, consisting of public and private organizations functioning at all levels of government—Federal, State and local. " The authority of Federal agencies is frequently limited, while responsibility is distributed in a fragmented way throughout the interorganizational network that constitutes the institutional environment. Thus, the Federal R&D agency seldom, if ever, has anything but a weak relationship with the agencies actually responsible for policy and program implementation. Although demonstrations have become an important part of R&D activity in these policy areas, their utility has been limited by both technical and institutional factors, as discussed at greater length in the next chapter.

"For a fascinating illustration of this point, see Donald Schon, "The Blindness System, " The Public fnterest, No. 18, Winter 1970, pp. 25-38.

Regulation

The scope of Federal Government regulatory activity has expanded markedly in recent years from its more traditional concerns with "markets, rates, and the obligation to serve" to include the conditions under which goods and services are produced and the characteristics of those goods. This expansion has blurred, if not erased, the prior distinction between regulated and unregulated industries. In addition, the scope of Federal regulation has also come to include activity by lower levels of government, as in the case of water pollution control standards applied to municipal sewage disposal. This expansion of regulatory activity has drawn the attention of an increasing number of commentators; 15 it is not our purpose to review this discussion here.

There is one aspect of the newer forms of regulation, however, that does bear strongly upon the use of demonstrations as Federal policy instruments. Regulations and standards are increasingly based upon technical, as distinct from economic, criteria. This is true, for instance, in the case of SO^2 stack-gas scrubbers, fabric flammability standards, and aircraft engine noise standards. [16] The precise values of these standards are often a direct function of the technological state of the art; statutes sometimes require the "best available technology" as an additional criterion. An increasing portion of Federal R&D funds is directed to generating the technical information required for these new standard-setting activities. In this context, demonstrations

"See William Lilley, 111, and James C. Miller, III, "The New 'Social' Regulation, " The Public Interest, No. 47, Spring 1977, p. 53.

"See, for example, Charles L. Schultze, "The Public Use of the Private Interest," Harper's, Vol. 254, May 1977, pp. 43-62, and Regulation, a new journal initiated by the American Enterprise Institute in summer 1977.

l6 See the following cases in Federal Demonstrations: Cale Studies–''Refuse Firing Demonstration (Solid-Waste-to-Fuel-Conversion Plant), " "Resource Recovery from Refuse, " "Poultry Waste Processing, " and the "Refan Jet Engine Program ."

have begun to take on an important role in proving or verifying given technologies. This represents the use of demonstrations in a policy-formulating manner.

A concomitant of basing regulatory standards on technical criteria is that the regulations provide a powerful force for diffusing technology. Indeed, the coercive quality of regulations probably provides a more powerful incentive to adopt new technologies than do the usual market forces. While this naturally provides an important opportunity for the Government to promote technological change, it simultaneously creates a responsibility to ensure that the change is, in fact, socially desirable. Demonstrations seem likely to be an important aid in making judgments concerning the worth of proposed standards.

Energy

Federal Government R&D investment in energy was, through the 1960's, primarily directed to the development of nuclear power through the programs of the AEC. A small amount of coal research was supported by the Department of the Interior, but little R&D was invested in other energy sources or energy conservation.

The AEC initiated the Power Reactor Demonstration Program in the mid-1950's, and this program was instrumental in the adoption of nuclear power by the private utilities. 17 The initial objective of this program was to generate R&D information and to involve commercial firms and utilities in the construction of nuclear powerplants. Two successive rounds emphasized construction of small power reactors for use in rural areas and foreign export and the development and exemplification of larger reactors.

The Federal Government's role in energy was markedly altered in 1973 by the action of the Organization of Petroleum Exporting Countries (OPEC) in raising the price of OPEC-produced oil. The AEC gave way to the Energy Research and Development Administration and the latter, in turn, to the new Department of Energy. R&D activity was increased across all energy technologies and, in the most significant policy departure, "commercialization" of new technologies became an important Federal goal.[18]

It is this altered Federal role with responsibility for "commercialization" that makes the energy area distinct from other domestic policy areas. The Federal Government is now engaged in the complex task of relating public investments in the development of new energy technologies to strategies for seeing those technologies used for energy production and conservation in the private sector. '9 The matching of public and private investment decisions, choice processes, and decision criteria is being worked out in a very complicated manner. Demonstrations, as it turns out, happen to be one of the policy instruments, however imperfect, being used in the search for an improved match. 20

Conclusions

Several conclusions emerge from the above discussion. First, the Federal role in a given policy area establishes the scope of the Federal R&D effort in that area. In national security, the Federal Government is primary and its role is comprehensive in scope. In basic and applied research, however, the Federal role is limited to that research generating external benefits, and duplication of private sector development work is not warranted. A second conclusion is that the several processes of generating scientific knowledge, incorporating that knowledge into useful technology, and building the associated institutional and professional capital nearly always require a long period of time. This is clearly the case in agriculture and national security, two of the most highly developed policy areas from an R&D perspective. There is no reason to suppose it less true in areas where scientific understanding and technological capability are less developed. Furthermore, if the Federal role authorizes or mandates that the R&D effort deal with the

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"See Wendy Allen, Nuclear Reactors for Generating Electricity: U.S. Development from 1946 to 1963, The RAND Corporation, R-21 16-NSF, June 1977.

"See MIT Energy Laboratory Policy Study Group, Government Support for the Commercialization of New Energy 'Technologies: An Analysis and Exploration of the Issues, Cambridge, Mass., November 1976.

"See Leland L. Johnson, Edward W. Merrow, Walter S. Baer and Arthur J. Alexander, Alternative institutional Arrangements for Developing and Commercializing Breeder Reactor Technology, The RAND Corporation, R-2069 - NSF, November 1976.

20 See Don E. Kash et al., Our Energy Future, University of Oklahoma Press, Norman, Okla., 1976, pp. 25-26 et passim.

utilization of R&D results, the use of demonstrations will be a derivative response. In agriculture and defense, for instance, the comprehensive Federal role led long ago to the equivalent of integrating demonstrations into the institutions and procedures of these sectors. In basic and applied research, on the other hand, because the Federal role is limited, the question of demonstrations has never been raised. In domestic policy, regulation, and energy, where R&D is performed to generate innovation, demonstrations are prevalent. Even so, it is not surprising that demonstrations have yet to be firmly established in domestic policy, regulation, and energy. These areas are relatively new, deal continuously with distribution of costs and benefits of policies among social groups, have complex institutional relationships with the private sector and with other levels of Government, and often manifest lack of consensus about the appropriate Federal role. Finally, the effectiveness of demonstrations will be determined by the contribution of the R&D effort to the technical problems of the operational world and by the institutional environment in which that relationship is set. This point is elaborated analy - tically in chapter III.

The Social Action Tradition

Demonstrations as a policy instrument have their roots in a second tradition, one of social action, [21] This tradition has as its concern those individuals, families, and groups deemed by society to have too few of the necessities and amenities that constitute an acceptable physical, economic, and social standard of living. Specifically, this tradition has championed the cause of the poor, the disadvantaged, and those who encounter discrimination and is manifest in policies like income maintenance, education of disadvantaged children, provision of adequate housing and health care, job training programs, and the like. Demonstrations here frequently have been organized and directed by individuals with little scientific or technical training—social workers, city and regional planners, teachers and school administrators, and public administrators.

The mid-1960's witnessed a significant and rapid expansion of Federal Government activities directed to the alleviation of a number of social ills. In the early days of the War on Poverty, for instance, "new programs to help the poor tumbled out of the White House and Congress in rapid succession, and idealistic Government officials worked frantically to get them started and confidently looked forward to quick and visible results. "[22] A wide range of far-reaching social legislation was enacted in a similar manner during this era.

Demonstration projects were a prominent feature of these social action programs. Often it was the case that demonstrations funded by non-Federal sources preceded the emergence of Federal programs; they constituted "prototypes" in the sense of indicating in particular instances the main lines that a larger invention might follow. " Demonstrations also were initially proposed as limited efforts to learn "what works, " only to be expanded to a broader program by Congress, as was the case for Model Cities. A third instance was the use of demonstrations to initiate a service provision program as in the community mental health centers funded by the National Institute of Mental Health.

Although the term "demonstration" suggested an effort to validate social intervention strategies, little about these demonstrations was systematic. They were described as "random innovation" by Rivlin.[24] (Try enough innovation approaches to a problem and some are bound to workout; or so it was thought.) Seldom were these demonstrations subject to good program evaluation, so little knowledge emerged of how effective programs could be used to make other projects more successful.

Even so, social action demonstrations commended themselves to policy makers for impor-

[21] See Martin Rein, Social Policy: Issues of Choice and Change, Random House, New York, 1970, pp. 138-152 et passim.

[22] Alice M. Rivlin and P. Michael Timpane, (eds.), Planned Variation in Education: Should We Giue Up Or Try Harder?, The Brookings Institution, Washington, D. C., 1975, p. 3..

[24] See, for instance, Terrance Keenan, "The Health Record of Private Foundations, " Journal of *Health* Politics, *Policy* and Law, Vol. 2, No. 1, Spring 1977, pp. 11-19, for discussion of the efforts of private philanthropic foundations to "craft and test the prototypes upon which government programs are modeled. "

Alice M. Rivlin, "Systematic Thinking *for* Social Action, The Brookings Institution, Washington, D. C., 1971, pp. 87-90.

tant reasons. They were a readily available means for making a prompt Federal response to a pressing social need, thus satisfying the "do something" injunction to policy makers. Beyond this, their execution occurred at local government levels, thus indicating action "where it counts. " In addition, they implied a strategy of rational social change—first demonstrations, then full-scale programs, thus carrying promise for Iongrun achievement. Furthermore, they were an accommodation to the problem of scarce resources, requiring substantially fewer resources than full-scale programs of intervention .25 This accommodation had a dual appeal: liberals could approve this as a strategy of "getting a foot in the door, " while conservatives could regard it as a second-best solution where the preferred course was no Federal program. Finally, demonstrations quite often were important in providing symbolic recognition by the Federal Government of claims for attention or resources by the important constituency group. These political uses of demonstrations, more prominent in the social action tradition than in the R&D tradition, retain their attractiveness in many situations today.

Gradually, for a combination of reasons, demonstrations in the social policy area began to be drawn into a more formal R&D tradition. This development was supported by research personnel in the agencies and by the Office of Management and Budget. A body of doctrine was developed about good and bad practices in the management of demonstrations. Project goals became more specific. The time duration of projects was more clearly indicated. Expectations were reduced. In some cases, demonstrations began to be viewed as a stage in program R&D development not unlike that characteristic of the program in the R&D tradition.

"See Rein, op cIt , pp 139-140.

Conclusions

Demonstrations in the social policy area today constitute one important means in the search by policy makers for ways to learn about "what works. " These policy makers have been taught by the experience of the 1960's and 1970's that "random innovation" leads to few generalizations that are widely applicable. They are generally convinced of the need for systematic accumulation of knowledge as a basis for the establishment of sound social policy. But they are also increasingly aware of the limits of R&D programs in general, and of demonstrations in particular. to generate that knowledge. The rhetoric surrounding demonstrations in the social policy area is similar, if not identical, to that in areas involving hardware demonstrations. But the confidence that demonstrations are the logical next step to move research results into operational uses is not as strong. Thus, we find demonstrations have developed from two quite different traditions, but that social demonstrations are increasingly being guided by an R&D perspective. The fact that the language and aspirations of social and hardware demonstrations are increasingly similar may mean that social policy and action are steadily being undergirded by a systematically developed knowledge base. Alternatively, it may mean that the language of the R&D tradition is only serving to mask temporarily the limited capacity of R&D to generate an adequate knowledge base for social policy.