The Role of Demonstrations in Federal R&D Policy

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FOREWORD

The Federal Government now spends about $28 billion per year on research and development (R&D) activities and facilities in the United States. With another $20 billion per year from the private sector, the total national investment in R&D approaches $50 billion annually.

Large though this total is, it portrays only a small portion of the overall impact of R&D on the economy and the quality of life in our society. Research and development is the engine that drives the currents of change in our civilization. From R&D stem the inventions, techniques, and processes that propel innovations through our economic and social system. Moreover, it has been estimated that, on the average, each person engaged in R&D eventually generates 6 to 10 other jobs throughout the economy. As a consequence, the $48 billion annual national investment in R&D has a massive multiplier effect on our entire socioeconomic system.

Therefore, it behooves Congress to consider this investment carefully and pay close attention to the ways in which it is allocated and used, as well as to the framework of laws, regulations, incentives, and constraints whereby the fruits of scientific research and development are converted into operational results.

Furthermore, R&D and the process of innovation help to determine the options and establish many of the parameters whereby specific technologies can be assessed for their potential impacts on society. In assessing a particular technology, the Office of Technology Assessment (OTA) compares its advantages and disadvantages with those of alternative technologies and assesses its impact on economic, social, environmental, and political factors within a perspective of probable future human needs, capabilities, and values.

To carry out its assessments effectively, OTA needs a thorough understanding of the Nation's R&D effort and of the process whereby R&D results are converted into useful innovations. While helping to strengthen and integrate OTA'S overall assessment activities, such understanding also enables OTA to assist Congress in better shaping the national investment in R&D by developing more soundly based R&D policies and priorities. Thus through such understanding, OTA can more effectively fulfill its mandate to give Congress early indication of the impacts of technological change.

In response to these needs and the urging of a number of congressional committees and individual Members, the OTA Board authorized a Program of R&D Policies and Priorities, which became operational in May 1976.

Recognizing that such an assessment cannot be carried out effectively through a single, comprehensive project which attempts to address all facets of the problem, the Program was designed to proceed through a series of manageable, interrelated studies which will help to build an understanding of how to maximize the beneficial impacts of our total R&D enterprise.

The Program has operated with the guidance of three interrelated Advisory Panels made up of distinguished leaders of science, technology, industry, labor, the professions, and the consumer, environmental, and public interest movements.

The Panel on the Health of the Scientific and Technical Enterprise, chaired by Dr. Harvey Brooks, Benjamin Peirce Professor of Technology and Public Policy at Harvard University, has been concerned with ways we can maintain and enhance the health and vitality of the entire scientific and technical enterprise.

The Panel on the Applications of Science and Technology, chaired by Dr. Lewis Branscomb, Vice President and Chief Scientist of the IBM Corporation, has been concerned with how we can more effectively apply science and technology to ameliorate the processes of innovation, augment America's international competitive position, solve national and social problems, and enhance the quality of life.

The Panel on Decisionmaking on R&D Policies and Priorities, chaired by Dr. Gilbert White, Director of the Institute of Behavioral Science at the University of Colorado, has been concerned with how we improve the decisionmaking processes whereby the Nation establishes policies and priorities for R&D.

During coming months, OTA will issue a series of reports on the Program, all intended to inform and aid Congress in dealing with the complex issues of R&D policies and priorities.

The second of these reports is *The Role of Demonstrations in Federal R&D Policies*. Demonstration projects are a significant instrument to aid in the formulation and implementation of national policy. More than $1 billion a year of Federal funds flow into demonstration projects; however, the effectiveness of demonstration projects to date has fallen far short of their potential.

This report analyzes the Nation's experience with demonstration projects to provide Congress with a perspective and a set of guidelines for evaluating and shaping proposed demonstrations. It is hoped this report will aid Congress in its authorization, appropriation, and oversight functions in: (1) determining when it is desirable to undertake demonstrations; (2) shaping legislative provisions to increase the likelihood of successful demonstrations; and (3) carrying out effective evaluation of demonstrations which have already been undertaken.

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SUMMARY

Demonstration projects have become increasingly popular as innovative responses to a broad spectrum of national problems. Federal expenditures for demonstration projects, including social program demonstrations, have grown to over $1 billion annually, and further growth appears likely. Yet their effectiveness has been limited.

Demonstrations are frequently used in areas, such as energy, where there is controversy concerning what constitutes desirable and timely innovations. To effectively evaluate proposed and ongoing demonstrations in such areas, Congress must be able to develop a set of realistic expectations for a demonstration's outcome. In order to provide this capability, the present report develops:

- A perspective that permits analysis of demonstrations in many policy contexts; and
- Guidelines to aid the evaluation of individual proposals for demonstration projects.

The perspective and guidelines are derived from analyzing the lessons learned in both social and hardware demonstrations.

Perspective

The perspective developed here encompasses both the different purposes of demonstration projects and the principal factors that determine success.

What is a Demonstration?

The term "demonstration" is ambiguous. It can mean to test an innovation for the purpose of formulating national policy. Or, it can mean to show others the relative advantage of an innovation for the purpose of persuading them to use it. We define a demonstration here as:

> A project in which an innovation is operated at or near full scale in a realistic environment in order to (1) formulate national policy, and/or (2) promote the use of an innovation.

The term "innovation" may refer to a new program, product, or process.

Policy-Formulating Demonstrations

We refer to the first type of demonstration project as a ***policy-formulating demonstration.*** Federal decisionmakers are its principal audience. The income maintenance experiments that examine the administrative feasibility, costs, and impacts of a variety of income transfer programs provide an example of this type of demonstration. Demonstrations that provide the necessary technical or economic information for setting regulations and standards are also a type of policy-formulating demonstration. The Refan program to reduce noise from commercial jet aircraft and inform regulatory decisions of the Federal Aviation Administration is an example. Typically, policy-formulating demonstrations are intended to provide information to Federal decisionmakers about:

- Technological and administrative feasibility of instituting a policy or adopting an innovation.
- Expected economic, environmental, and social impacts of the policy or innovation.

Policy-Implementing Demonstrations

We refer to demonstrations to promote the use of an innovation as ***policy-implementing demonstrations.*** Solar heating demonstrations are an example. The criterion of success for this type of demonstration is diffusion of the innovation from the demonstration site. Thus, those non-Federal decisionmakers who control the rate of diffusion of an innovation are the principal audience for these demonstrations. In addition to the factors mentioned above for policy-formulating demonstrations, policy-implementing demonstrations are typically intended to provide information on:

- Costs of adopting and using the innovation.
- Reliability of that innovation in use.
- Demand for the innovation.
- Feasibility of implementing the innovation at the adopter's site.

The common denominator of both types of demonstrations is the generation of information for decisionmaking, and a single project may incorporate elements of both types of demonstrations.

Who Expects What From a Demonstration?

Demonstrations often serve important political as well as information functions, such as providing:

- A compromise between those who prefer a large-scale operating program and those who prefer nothing.
- A means of expressing concern for a national problem.
- A response by executive agencies to pressures to show the usefulness of their R&D program.

Furthermore, because demonstration projects are an instrument of transition from R&D to use, an innovation may be simultaneously moving:

FROM	TO
Small scale in the laboratory	Full scale in the field;
Control by R&D personnel	Control by operating personnel;
Technical criteria of success.	Institutional criteria of success;
Federal management	Private sector management or State and local management.

The range of different but limited perspectives involved makes a transition such as this difficult to bring about and complicates the evaluation of proposed demonstrations.

All of these factors imply that various interested parties often have different objectives and expectations from a demonstration project. Some may view it primarily as a test of an innovation; others may view it as a promotion of an innovation; still others may view it primarily as a means of expressing concern for a national problem.

These different objectives and expectations make the evaluation of a demonstration difficult and necessarily judgmental. Nonetheless, such judgments can be informed by realistic expectations of a demonstration's outcome.

Institutional Environment, Technology, and Success

There are two essential requirements for a successful demonstration project: (1) clearly specifying the relevant information to be generated, and (2) generating reliable information once specified. The specification of the relevant information depends largely on the ***institutional environment;*** reliability of the information generated depends largely on the ***technology*** (pp. 22-27).

An institutional environment is characterized by the users of an innovation, its suppliers, markets, and regulators of those markets. A well-developed institutional environment has two characteristics—a tradition of using the results of R&D, and an accepted Federal role. In such an environment there is generally consensus among the various participants as to what constitutes a desirable innovation and when a demonstration is appropriate. An example of such a well-developed institutional environment is the agricultural sector with its system of experiment stations, land-grant colleges, and extension agents. Conversely, the components of the institutional environment in the elementary and secondary education system are unevenly developed, poorly linked, and frequently in disagreement over the process of change in the schools. In the public sector, there is often a lack of consensus—and even fundamental value and goal conflicts—regarding the desirability of innovations. In the private sector, the discipline of the marketplace tends to force a greater degree of consensus as to what constitutes a desirable innovation.

The term "technology" refers here to knowledge for the production and delivery of goods and services. Some technologies, such as central-station electric power generation, are well developed, with well-characterized inputs and outputs and a good understanding of their relationship; other technologies are poorly developed, as in education and law enforcement. Demonstrations employing poorly developed technologies are less likely to be perceived as generating reproducible results than those employing well-developed technologies.

The Federal role in a given policy sector determines the scope of the Federal R&D effort in that sector, and consequently, the role of demonstrations (pp. 9-15). In many areas of domestic policy a major Federal role is relatively new and often controversial. In areas where the Federal role is still controversial, and it is difficult either to reach consensus as to relevant outcomes or to generate reliable information, the effectiveness and role of demonstrations remain to be clearly determined. The experience in agriculture suggests that an extended period of time is required for an effective and accepted Federal role to be established.

Guidelines for Evaluating Proposed Demonstration Projects

The following questions focus attention on key factors that influence success in demonstration projects (pp. 31-41). The brief discussions attempt to provide the necessary perspective by which one can evaluate critically the answers to these questions.

1. Are the goals for a demonstration project clearly articulated and agreed upon?

A divergence of goals and expectations among funders, performers, and potential audiences may often be inevitable. Nonetheless, to avoid an inadvertent lack of clarity in goals, an effort should be made to ensure that program managers and performers of demonstrations share a common understanding of the purposes of demonstrations. Specifying how the results of a demonstration are to be evaluated can be an effective device for clarifying goals.

2. Given the purposes of a demonstration project, 'have the information needs of the demonstration's audience been adequately considered?

A demonstration may be intended to inform a congressional debate on a welfare system. Or, a demonstration may be intended to promote the commercialization of a new energy technology. In either case, the demonstration should be designed to address the critical issues upon which the decisions will turn, as perceived by the relevant decisionmakers themselves.

This assumes, of course, that the necessary decisions can be effectively informed by a demonstration. For example, policy-implementing demonstrations by themselves have been weak means for bringing about institutional change. In such cases, other measures, where available, should be considered as alternatives or complements to demonstration projects (pp. 48-51) .

3. If the demonstration is intended to promote the diffusion of an innovation, have key actors in the institutional environment been involved?

It is not only important that an institutional environment be sufficiently well developed to generate a consensus on the criteria for successful innovations. Diffusion of an innovation is also enhanced by the actual involvement of an institutional environment's key actors in the planning of a policy-implementing demonstration.

An illustrative example is provided by a demonstration of mechanized refuse collection aimed at reducing labor costs through smaller collection crews. The mechanism was designed by city personnel, but no garbage truck outfitting firm was involved in the demonstration. Despite striking success at the demonstration site, no commercial firm could be found to market the innovation, and there has consequently been little diffusion.

4. Is the technology incorporated in a demonstration sufficiently reproducible to be credible?

Projects incorporating poorly developed technologies seldom lead to similar operations in other locations. For example in education, significant innovation appears to occur at a site only when there are major adaptations in the innovation to meet local needs. The apparent requirement for a unique implementation of an innovation at each potential adoption site tends to preclude its replication elsewhere.

Support for local problem-solving efforts where diffusion is not a relevant success criterion might be better termed "subsidized local development" than a demonstration project. Although few such efforts have survived withdrawal of the Federal subsidy, such support might still be useful where a genuine commitment to address real problems can be distinguished from mere opportunism in response to available funds.

Extensive adaptation of an innovation to meet specific local needs may also occur where technologies of substantial reproducibility are used in a larger "system ." Examples include mass transit, law enforcement hardware, and mining. For technologies of low to intermediate reproducibility, successful replication at multiple sites may be necessary to stimulate diffusion.

5. Is the technology being demonstrated well in hand?

Even though a technology may be potentially reproducible with great reliability, its development may not have proceeded to the point where it is well in hand. There is persuasive evidence that attempts to demonstrate a technology that is not well in hand adversely affect diffusion.

For example, extensive development work was required during the demonstration of a desalination process in Freeport, Tex. Although this work led to important improvements in performance, it also caused interruptions in plant operations. Potential adopters of desalination plants mistakenly perceived these interruptions as an indication that the desalination process was unreliable, and there has been no diffusion.

This example illustrates the importance of considering the alternative of a full-scale test at a test-bed facility when a technology is not yet well in hand. Such testing would avoid both conveying the adverse impression of unreliability to potential adopters and facilitate engineering solutions to technical problems by removing real-world operating constraints.

6. Is there sufficient time and operational flexibility for the demonstration to meet its objectives?

Strict time constraints generated by policy or political needs have seriously impaired demonstrations from achieving diffusion success. , operational flexibility is essential for coping with unanticipated difficulties that fre- ** appear in such projects.

7. Is there sufficient evidence of commitment to the innovation by the performer?

Cost sharing and initiative by non-Federal participants in a policy-implementing demonstration provide an important test of user need. It maybe difficult to distinguish opportunism as a response to available funds from a commitment to address real problems without a significant measure of cost sharing.

Failure of the private sector to assume a substantial portion of the costs and risks is itself informative, and may indicate the technological, market, institutional, or environmental uncertainties are too high. A demonstration would then be premature without prior steps to reduce such uncertainty.

Alternatively, the innovation may simply be uneconomic. Failure to commercialize would then have nothing to do with the lack of knowledge that could be produced by a demonstration project. In such a case, policies that change the incentive structure facing the potential innovator should be considered as an alternative to a demonstration project, or the commercialization effort should be delayed until further R&D or changed economic conditions make it more attractive.

8. Does the design of the demonstration project reflect the experiences of past demonstrate ions?

Any well-conceived and well-executed demonstration project strives to reduce uncertainty in the various dimensions of a problem. However, the failure of a demonstration may highlight dimensions of a problem whose significance was not adequately appreciated. The insights gained can be used to reformulate national policy or be incorporated into the design of future demonstrations.

For example, at the time of the Atomic Energy Commission's first power reactor demonstrations, electric utilities could not obtain liability insurance against nuclear accidents. The recognition of **this** barrier to the diffusion of nuclear power led to passage of the Price-Anderson Act which imposed a legal limit on damages that could be claimed after a nuclear accident. By creating a more favorable institutional environment, further demonstrations were able to succeed in promoting the diffusion of nuclear power. Further demonstrations by themselves, however, would have been unable to overcome this barrier which had nothing to do with the lack of information that could be produced by a demonstration project.

Conclusion

Despite their obvious potential, demonstrations can be easily misused. The perspective and guidelines developed here are to help Congress more effectively utilize this important policy instrument for pursuing national goals.

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INTRODUCTION

Chapter I

INTRODUCTION

Demonstration projects have become increasingly important in Federal Government research and development (R&D) programs. They are used in such diverse areas as energy, transportation, environmental quality, health, water resources, aeronautics, education, and income maintenance. The resources allocated to demonstrations are substantial. One study estimated that approximately $625 million of the Federal civilian R&D budget was allocated to demonstrations in FY 1974; [1] an update of that estimate placed the funds for demonstrations at roughly $860 million for civilian R&D in FY 1977.[2] Another study estimated funds of $400 million for social program demonstrations in FY 1976.[3] Reliable data for prior years are not available; it is clear, however, that Federal support for demonstrations has increased at a rapid rate and that continued increases in funding are likely.

It might be reasonable to assume from their apparent popularity that demonstrations are a well understood and highly effective instrument of Federal policy. But this is not the case. Demonstrations are poorly understood and their effectiveness is open to question.

One reason for our limited understanding of demonstrations is the lack of an agreed upon definition. An analyst, several years ago, referred to "the 'demonstration-research' project as the major instrument for social planning in American communities today. "4 Another analyst of social programs distinguished among experimental, developmental, and demonstration projects, defining the latter as aimed at "showing administrative and/or political feasibility. "s A forthcoming study of social research and development by the National Academy of Sciences (NAS) defines a demonstration as "a small-scale program undertaken in an operational setting for a finite period of time to test the desirability of a proposed course of action ."s A recent study of energy policy defined the purpose of energy technology demonstrations as "providing hardware and nonhardware information with sufficient reliability and credibility to inform commercial utilization decisions.'" Last, the most extensive empirical study to date of demonstrations referred to "activities undertaken at sufficient scale so that results can be easily translated into regular commercial operations" and distinguished this from pilot plant and field test activities that "involve operation on a smaller scale to determine technical feasibility, to identify major problem areas, and to provide early estimates of costs. "8

The various usages of demonstrations reflect semantic ambiguity about the term. There are, however, two principal meanings that underlie most discussions. The first is that demonstrations are intended to *prove: to* test, validate, and prove the innovation under consideration. The second is that demonstrations are intended to show others the relative advantages of an in-

'Walter S. Baer, Leland L. Johnson, and Edward W. Merrow, Analysis of Federally Funded Demonstration Projects: Final Report, The RAND Corporation, R- 1926 -DOC, April 1976, p. 2. Hereafter, this study will be cited as Federal Demonstrations. A supplementary volume of case studies is Waker Baer, C. Johnston Conover, Cheryl Cook, Patricia Fleischauer, Bruce Goeller, William Hederman, Leland Johnson, Edward Merrow, Richard Rettig, and John Wirt, Analysis of Federally Funded Demonstration Projects: Supporting Case Studies, The RAND Corporation, R-1927-DOC, April 1976. This volume will be cited as Federal Demonstrations: Case Studies.

'See Walter S. Baer, Leland L. Johnson, and Edward W. Merrow, "Government-Sponsored Demonstrations of New Technologies." Science, Vol. 196, May 27, 1977, p. 951.

[3]See the Report of the Study Committee on Social R&D, The Federal investment in Knowledge of Social Problems, The National Academy of Science, Washington, D. C., forthcoming, 1977.

'Martin Rein, Social Policy: Issues oj Choice and Change, Random House, New York, 1970.

'Walter Williams, Social Policy Research and Analysis: The Experience in the Federal SoCml Agenc~es, American Elsevier Publishing Company, New York, 1971, pp. 53-54.

'The Federal Investment in Knowledge O) Socia) Problems, op. cit.

'Don E. Kash et al , Our Energy Future, The University of Oklahoma Press, Norman, Okla., 1976, p. 25

'Federal Demonstrations, p. 19.

novation for the purpose of persuading them to use it. Incorporating both these meanings into our analysis, we have adopted the following definition:

> A demonstration is a project, involving an innovation and operated at or near full scale in a realistic environlnent, for the purpose of (1) formulating national policy or (2) promoting the use of the innovation.

The term "innovation, " as used in this study, may refer to a new program, product, or process. The "use of an innovation" in our definition encompasses the stages of adoption, implementation, and incorporation.

The ways that Congress has provided statutory authorization for demonstrations indicate the range of their intended uses. Frequently, a broad authorization for R&D activity, without specific reference to demonstrations, has provided the basis for agency demonstration projects. The Maritime Administration, for example, has conducted its ship development and construction demonstration program under authority to conduct "research and development activities. " A second pattern has been congressional authorization of demonstrations for which the objectives have been broadly defined. The Bureau for Education of the Handicapped, for instance, has broad authority to support "demonstrations relating to education of handicapped children" and "demonstrations relating to physical education or recreation for handicapped children. " Congress has also authorized demonstrations and specified their objectives. The solid waste demonstration authority of the Environmental Protection Agency is for "the development and application of new and improved methods of collecting and disposing of solid waste" as well as "processing and recovering materials and energy from solid waste. " Congress has on occasion provided specific authority for particular demonstration projects. In 1956, for instance, Congress authorized the "construction, outfitting, and preparation for operation . . . of a nuclear-powered ship, " which became the IV. S. Sauannah. Nevertheless, the two primary meanings of proving and of showing are clear, even from these various statutory formulations.[9]

More important, perhaps, than the absence of clarity about the meaning of demonstrations is that the results of their use have been discouraging. Some of the main conclusions of one recent study, for example, include the following: "demonstration projects have a narrow scope for effective use; " "demonstration projects appear to be weak tools for tackling institutional and organizational barriers to diffusion ;" "large demonstration projects with heavy Federal funding are particularly prone to difficulty. "lo From other sources, come additional criticisms. [1]1 Demonstrations, it is argued, provide little generalized information because they are often characterized by poor research designs. They seldom are replicated beyond their initial sites, nor do they often lead to commercialization. Many conclude that demonstrations provide little additional information that could not be obtained more inexpensively by other means.

Thus, Congress has good reason to be concerned with demonstrations. First, because Congress appropriates funds for demonstrations, the substantial amount of resources invested in them is in itself reason for congressional attention. What is the Federal Government receiving for its money? What might be better alternative uses of these funds? Second, because Congress provides authorization for demonstrations, an understanding of their appropriate uses and limits is needed for informed decisionmaking on new initiatives. Should authorization be broad or specific, providing substantial or limited administrative discretion? Should demonstrations be authorized by themselves or in relation to other policy instruments and tools? Third, because statutory authority is reviewed regularly and performance of programs assessed periodically through the reauthorization and oversight processes, criteria for the review and evaluation of demonstrations can be helpful. When should demonstrations be employed? How should they be managed? What are the most likely predictors of success?

Purposes of This Study

- To develop a conceptual framework for the analysis of demonstration projects.

Vhis material is drawn from an analysis by Christopher J. Conover of The RAND Corporation, "Federal Demonstration Projects: Statutory Language to Fund Demonstration Projects, " prepared for the Federal Demonstrations study.

'"Federal Demonstrations, pp. v, vi.

"See, for example, 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.

- To review and synthesize the literature on demonstrations in relation to this conceptual framework.
- To draw out implications of the analysis for congressional action.

Each of these purposes deserves further comment.

Conceptual Framework

Demonstrations, as is indicated above, have been used both with physical technologies and social programs. Yet no study has attempted to analyze hardware and social demonstrations together. One objective of the conceptual framework developed below is to permit the analysis of demonstrations in many policy contexts, including both physical and social technologies. A related objective is to determine whether there are lessons that can be learned from the use of hardware demonstrations that have utility for social demonstrations, and *uice uersa*. Last, an objective of this study has been to understand the contribution of demonstrations to the different stages of the policy process by distinguishing between those that generate information useful for formulating national policy and those undertaken for the purpose of promoting the utilization of a technology.

Review of the Literature

The literature that constitutes the basis for this study is indicated in the bibliography. It falls into four principal categories. First, there are two studies that focus directly upon demonstrations as policy instruments, both done by the RAND Corporation. One of these is the Federal *Demonstrations* study, cited above, performed for the Department of Commerce. The other is the "change agent" study of educational demonstrations conducted by Berman and McLaughlin for the Office of Education. 12 The second category of literature consists of two retrospective analyses of specific social experiments, both sponsored by The Brookings Institution. '3 One, by Pechman and Timpane, reviews the New Jersey negative income tax experiment. 14 The other, by Rivlin and Timpane, reviews the experience with planned variation in education. 15 Third, there is a general literature on R&D utilization and commercialization that is relevant to demonstrations but in an indirect way. The forthcoming NAS report on social R&D is a case of this type. 16 Finally, there are prescriptive analyses of R&D issues. The analysis by Kash, et al., of U.S. energy options illustrates this type of analysis. 1. In this report, we draw upon the literature to support or challenge propositions that emerge from our conceptual framework. Thus, this study is not a conventional literature review but an analytical interpretation and extension of the literature.

Guidelines for Congress

Previous studies of demonstrations have directed their policy recommendations primarily to the Federal agencies sponsoring demonstrations. Congress, however, has responsibilities for the authorization of demonstrations, appropriation of funds to support them, and review and evaluation of program performance. An important purpose of this study, then, is to analyze the literature and experience of demonstrations in the context of congressional concerns.

"See Paul Berman and Milbrey Wallin McLaughlin et al., Federal Programs Supporting Education Change, Vols. l-V, The RAND Corporation, R-1589 l-HEW, September 1974 and R 1589 2-5-HEW, April 1975,

'[3] For the purposes of this study, we do not distinguish between social experiments and social demonstrations. The major difference between these two types of projects lies in the nature of the evaluation by which the effects are determined rather than in the fundamental purposes they serve. See Henry W. Riecken and Robert F. Borouch (eds.), Social Experimentation: A Method for Planning and Evaluating Social lnteruention, Academic Press, New York, 1974, chapter 1.

'*Joseph A. Pechman and P. Michael Timpane (eds.), Work incentives and Income Guarantees: The New Jersey Negatiue Income Tax Experiment, The Brookings Institution, Washington, D. C., 1975.

"Alice M. Rivlin and P. Michael Timpane (eds.), Planned Variation in Education: Should We Give Up Or Try Harder?, The Brookings Institution, Washington. D. C., 1975,

"See also Arthur D. Little, Inc., Federal Funding of Civilian Research and Development, Volume 1: Summary, Washington, D. C., February 1976.

"Don E. Kash et al., Our Energy Future, University of Oklahoma Press, Norman, Okla., 1976.

Format of the Study

Chapter 11 includes a brief overview of the historical context from which demonstrations have evolved. Chapter 111 develops a conceptual framework for analyzing policies for using demonstrations. This framework is used in chapter IV to develop several propositions concerning factors likely to affect the success of demonstrations. In the concluding chapter, chapter V, we trace the implications of the analysis for Congress.

As this report will make clear, experience and the research literature provide no infallible guides to good policy concerning demonstrations. Problems that arise from using demonstrations are the result of the institutional complexity of the public and private sectors and the workings of a democratic government. We hope that a treatment of this complexity will be helpful to Congress and others for future action.

Chapter II

THE HISTORICAL CONTEXT OF DEMONSTRATIONS

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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 in terest 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

'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.

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

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

"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.[19] 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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[17] See Wendy Allen, Nuclear Reactors for Generating Electricity: U.S. Development from 1946 to 1963, The RAND Corporation, R-2116-NSF, June 1977.

[18] 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.

[19] 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 analytically 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..

[23]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. "

[24]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.

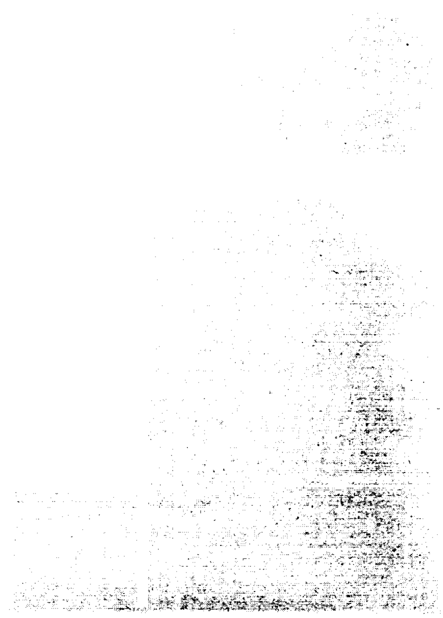
"See Rein, op cIt , pp 139-140.

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.

Chapter III

A CONCEPTUAL FRAMEWORK FOR THE CONSIDERATION OF DEMONSTRATION PROJECTS IN FEDERAL R&D POLICY



Chapter III

A CONCEPTUAL FRAMEWORK FOR THE CONSIDERATION OF DEMONSTRATION PROJECTS IN FEDERAL R&D POLICY

Our approach to demonstrations is from an R&D perspective. It is not a narrowly technical perspective, but one that explicitly recognizes the way that political and technical factors interact in demonstration projects. In this way, we believe that a conceptual framework can help in understanding the uses and limits of demonstrations as a policy instrument.

This chapter sets forth a conceptual framework within which to examine demonstration projects. We examine the purposes of demonstration projects in meeting R&D objectives and other policy goals and review the general factors that affect the probability that demonstration projects will achieve these purposes. Throughout we draw upon the literature to provide illustrations and support for the analysis.

The Purposes of Demonstrations

The purposes of demonstrations can be considered from two quite distinct perspectives: purposes related to the development and application of knowledge through an R&D process, and their uses within a political process.

Demonstrations in the R&D Tradition

Within the R&D tradition there are two fundamental purposes for a demonstration project:

- To aid Federal policy makers in deciding whether or not to adopt a policy.
- To promote the use of an innovation.

Demonstration projects in which the first purpose predominates we refer to as ***policy-formulating demonstrations;*** projects in which the second purpose predominates we call ***policy-implementing Ciemonstrat#ons.***

A good example of policy-formulating demonstrations is the income maintenance experiments conducted by the Office of Economic Opportunity (OEO) and the Department of Health, Education, and Welfare. These experiments were begun in the late 1960's and continue at the present time. They have sought to provide information to policy makers concerning the effects of income maintenance payments upon the work incentives of the participants in the programs, the administrative feasibility of implementing such a program, and the difficulties of integrating income maintenance programs with other service programs such as manpower training. The emphasis upon the work incentives reflected the beliefs of the demonstration's sponsors concerning the likely focus of a policy debate over welfare reform. The sponsors in OEO felt that a major congressional concern would be whether individuals who receive some form of guaranteed income would withdraw from the labor force and become permanent members of the welfare population.2

An example of a policy-implementing demonstration is those conducted by the Shipbuilding Research, Development, and Demonstration program; through this program, the Maritime Administration is attempting to stimulate innovation in the shipbuilding industry by organizing an interindustry consortium of shipbuilding firms to propose and assist in managing demonstration projects. The projects with this program invoke

‘We define innovation as a program, product. or production process in the particular existing context: innovation is not necessarily new in the sense of “first instance. ”

‘Joseph A. Pechman and P. Michael Timpane (eds.), Work incentives and income Guarantees: The New Jersey Negatiue Income Tax Experiment, The Brookings Institution, Washington, D. C., 1975, pp. 15-24.

the development and testing of a new technological device or production method, which is followed by a formal demonstration in a shipyard to which all industry engineers are invited. Most of the projects are small and concern the pragmatic "nuts and bolts" problems of shipbuilding, not large-scale demonstrations of significantly new technologies. The projects have included new techniques of welding, surface coating, materials handling, and automation.[3]

In all cases in this paper, our perspective is that of a Federal policy maker. This caveat is important. It is quite possible that the firm or institution carrying out a project the Federal Government views as a policy-implementing demonstration conceives the project as a means of formulating its own "policies. " But because we are examining demonstrations sponsored by the Federal Government, our analysis is from the perspective of the Federal policy maker.

Moreover, individual demonstration projects can possess elements of both policy-formulating and policy-implementing purposes. A project that begins as a test of the worth of an innovation may ultimately serve as an exemplary demonstration for other sites that are funded under a new Federal program created as a result of the test. Alternatively, a demonstration project may be initiated to promote what is considered to be a proven concept but, as a result of adverse experiences in the early stages of the project, it becomes a means of testing the worth of the concept. A project may also possess different purposes, as perceived by the various actors concerned with its execution. The funder of a project may view the project as a test of a concept; the manager, as a means of promoting the use of an innovation whose worth has already been proved.

Although a demonstration may possess elements of both purposes, the distinction is important. If policy makers do not specify the purposes of a demonstration, agencies conducting the demonstration are free to view its purposes from the perspective that best suits their individual needs. This may result in the promotion of the use of innovations that Congress or executive policy makers do not feel are proved: demonstrations that these policy makers view as policy-formulating are viewed by the agencies as policy-implementing. Alternatively, agencies may treat programs as experimental that Congress sees as a means of implementing desirable policies.

For either policy formulation or policy implementation, the value of demonstrations should be based upon their ability to provide more credible information to either policy makers or potential users of innovations than would be available from other R&D methods. A project's scale and the realistic environment within which it is tried are the major contributors to this credibility.

Policy-formulating demonstrations should provide information to Federal policy makers about:

- Technological and administrative feasibility of instituting the policy or adopting the innovation on a wider scale.
- Expected economic, environmental, and social impactsof the policy or innovation.
- Relative merits of alternative policies or innovations intended to meet the same needs.
- Unanticipated consequences of adopting a particular policy or innovation.

In seeking to provide this information, demonstrations may help to clarify the nature of the policy problem itself. For example, the New Jersey income maintenance experiment highlighted the sensitivity of program costs to the frequency and manner of assessment of a family's income, an issue that was given little attention in early legislative planning. The experiment also provided detailed information on the variability of the incomes of the working poor.[4]

Negative information, information concerning the shortcomings of an innovation, may also be an important output of policy-formulating demonstrations. Because these demonstrations take place before a commitment to a course of policy, negative results can be used to support a decision to abandon consideration of the policy. '

Policy-implementing demonstrations should provide many of the same types of in-

[3]Federal Demonstrations: Case Studies, pp. E-1 - E-6.

[4]Pechman and Timpane, op. cit, pp. 207-214.

[5]0E0's experiment with Educational Performance Contracting is a good example. See Edward M. Gramlich and Patricia P. Koshel, Educational Performance Contracting, An Evaluation *of* an Experiment, The Brookings Institution, Washington, D. C., 1975.

formation to potential users of information. However, the emphasis is typically placed upon

- Costs of adopting and using the innovation.
- Reliability of that innovation in use.
- Demand for the innovation.
- Feasibility of implementing the innovation at the adopter's site.

Inherent in the definition of purposes of demonstrations is a specification of audiences. For policy-formulating demonstrations, the audience is the Federal Government and the constituencies that seek to influence Federal policy; for policy-implementing demonstrations, potential users of the innovation. Two classes of users can be identified: "final" users—private consumers, local governmental units, or individual firms; and "intermediary" users—suppliers of equipment, for example. Planning for a demonstration should involve clear identification of the audience and a determination of their information needs.

These two types of demonstrations should be distinguished from two other types of activities that share some characteristics of demonstration projects. We do not consider large-scale engineering tests of hardware *components* to be demonstrations. Such projects, which typically test scaled-up components of an innovation process or product, neither test a full "system" nor take place in a realistic operating environment. For example, aircraft engines may be run in large test cells or even mounted on test aircraft before being integrated into prototype systems. Such activities are potentially quite important to the development of new products but should be considered part of development rather than an instrument for promoting the transition from development to use.

The second type of activity that we exclude is the projects that are created as a result of Government subsidies for local *development.* In a number of social programs, for example, funds are provided to local political jurisdictions to develop innovative activities. The Law Enforcement Assistance Administration (LEAA) has provided such funds to police departments; Title IVC of the Elementary and Secondary Education Act supports innovative projects that relate to local or State school needs. Projects such as these are generally not considered as means of promoting the use of a particular innovation. Rather, they place the responsibility for innovating on the local jurisdiction itself.

Demonstrations as Instruments in the Political Process

The purposes of demonstrations can also be viewed in terms of their usefulness within our political system. Demonstration projects are a means of showing political initiative at relatively low budgetary cost. They are an attractive compromise between the advocates of sweeping policy or program change and the supporters of the status quo. They can help promoters of a policy to "get a foot in the door" to build a constituency. By demonstrating a concern for an issue or a particular group, demonstrations can become significant symbolic acts. They can assist Federal R&D managers to gain a political constituency. Demonstrations permit an R&D program manager to maintain some momentum in his program if the political support for expansion does not otherwise exist. Finally, demonstration projects can serve the needs of traditional pork barrel politics.

These are important functions within our governmental system because there are many issues on which compromises are needed. In the absence of such compromises, we would often reach an impass between advocates and opponents of a policy. A demonstration project may permit concrete experience with a policy to be obtained to settle the debate. It may provide a vehicle through which a particular interest group can establish a dialogue with elements of the Government. A demonstration can provide an important governmental gesture of concern for individuals facing difficult problems when the Government does not know how to solve those problems.

The fact that a demonstration is a compromise poses substantial problems for a project with R&D objectives. The parties to the compromise have a variety of objectives and frequently the compromise itself will not specify which of these objectives should predominate. The Follow Through Program illustrates this problem well. Follow Through was proposed as a program to provide continuing compensatory educational services to schools with disadvantaged children coming from Headstart preschool programs. Advocates of the program argued that such continued services would prevent the students from losing the gains they had achieved in their

Headstart programs. Opponents argued that there were insufficient funds to support such a program and in any case there was no evidence that it would be effective. The compromise was a "planned variations" program to test the effectiveness of different program designs. [6]

The advocates of an operating program sought quick implementation and, as a consequence, most of the programs were incompletely designed. In addition, the experimental design necessary to detect differences among programs was deemed inappropriate by the operating officials. The absence of clearly defined goals led the evaluators to collect data having only marginal usefulness. While there have been some useful outcomes, it seems unlikely that they are commensurate with the costs that were incurred. An important cause of this low yield was the conflicting goals of the parties to the compromise and the failure to resolve these conflicts in the design of the program.

The political uses of demonstrations will lead to projects with multiple and often conflicting objectives. Those groups that are involved will frequently possess "hidden agendas" that may interfere with the R&D objectives of the project. The absence of a clear consensus about goals may weaken project management and lead to inconclusive evaluations. A major task of both the executive branch and Congress should be to recognize both the political and R&D functions of demonstration projects and to design projects in a manner that minimizes the adverse interactions of the goals.

In the next section we address the factors that affect the success of demonstration projects as part of the R&D tradition rather than as instruments in the political process. Our concluding section will consider how the political and R&D uses of demonstrations can usefully be melded together.

General Factors Affecting the Success of Demonstrations

Many factors affect the success of a particular demonstration project: the quality of the project staff, the appropriateness of its goals, the adequacy of the funding, and the nature of the political and physical environment. Moreover, these factors will affect the outcome of demonstration projects in every policy area. Our interest, however, is not to investigate how an individual project can be most successfully executed once a decision has been made to initiate it. Rather, we seek to understand the types of situations in which well-executed demonstrations are most likely to be successful in reaching their objectives.

Our review of the literature leads us to suggest that two factors are likely to be of prime importance in determining the success of a demonstration project: first, the nature of the technology that is being demonstrated; second, the nature of the institutional environment within which a demonstration must be carried out.

The Technology

As we have noted, we use the term "technology" to denote the *inputs,* outputs, *and theory relating them that are associated with the innovation under consideration,* [7] The technology of the automobile is thus the inputs of personal time and invested capital, the output of transportation services, and the theories that relate the inputs to outputs that are embodied in the automobile itself. Two points deserve note. First, the definition of a technology is a matter of convenience. We can discuss the technology of an automobile or we can enlarge the concept to discuss the technology of an urban transportation system. The choice of the scope of the technology depends upon the purposes for which the concept is used. In this report, the scope is associated with the innovation whose demonstration is being contemplated. If the innovation is an electric automobile, the technology would be the automobile itself. If the innovation were a van carpool system, however, the technology would extend beyond the vehicle to encompass the system of roads, the manner in which carpools are formed, the location of work and living sites as inputs, and transportation services as outputs. The theories that relate these inputs are no longer solely embodied in physical entities but extend to institutions and behavioral responses.

Second, the theories and inputs associated

'Alice M. Rivlin and P. Michael Timpane (eds.), Planned Variation in Education: Should We Give Up Or *Try* Harder?, The Brookings Institution, Washington, D. C., 1975, chapter 1.

'Our use of the term "technology" is similar to that of economists who are concerned with production functions.

with differing technologies vary substantially in quality. These variations are important to understanding the impact that the quality of a technology has on the usefulness of demonstration projects as policy tools. Technologies differ in the degree to which their inputs involve important uncontrollable variability. Thus, the inputs of an education technology such as a reading program include teachers and students whose capabilities vary substantially. The technology associated with a large coal powerplant involves inputs of coal and water whose characteristics are predictable and have little variance for a single plant. Technologies also differ in the degree to which the inputs interact and change in the course of the transportation to outputs. In education, the qualities of teachers can be modified as they work to change the skills and other attributes of the students. For example, teachers can become more or less directive in their instruction or change their allocations of time among students. In the case of the powerplant, the coal does not change its attributes in unpredictable ways as it enters the process of producing power. Finally, technologies differ in the nature of their associated theories. For a technology such as power production, the theories that underlie the transformation of the inputs to outputs and residuals are quite deterministic and provide high confidence that certain inputs will lead to predictable outputs. In the case of education, the theories that relate inputs to outputs either do not exist or can predict outputs only within very broad ranges.

For some technologies, theory can be improved through research, development, and testing. While we may not be sure that a new design for an internal combustion engine will have high fuel efficiency and useful power output, we are confident that the developing and testing will allow us to perfect the technology's theory in the sense that we have used the term. In other cases, we are far less confident that we can produce such theory through R&D processes. For example, incentive systems for encouraging the insulation of houses can be designed and tested but will probably never reach a point where we may confidently predict that a particular individual, faced with the incentives, will make a particular decision. Even without the capability to make such exact predictions, however, decisionmakers can reduce the uncertainty concerning the behaviors of groups of individuals. Thus, while the theory may not be as deterministic as that associated with internal combustion engines, it is useful to a policy maker and it can be improved through R&D. In other areas, however, theory may be at such a primitive stage that it cannot be readily perfected through R&D. This may well be the case with police patrol procedures, where the relationship between the frequency of patrols, the type of patrol, and the type of site on the one hand and the occurrence of crimes on the other seems to be beyond our present capacities to discover.[8]

These qualities of a technology can be conveniently characterized in essentially two ways. The first of these is the degree to which a technology *is reproducible* from site to site. With what confidence can the policy maker or the industrial firm say that the use of the innovation will result in the transformation of inputs into desired outputs? This will depend upon the variability of the inputs, their tendency to interact or modify themselves in the course of the transformation, and the quality of the theory that exists. In general. technologies that are substantially embodied in hardware would be quite reproducible, while those that involve processes of human interaction would be relatively nonreproducible. Some technologies occupy a middle ground. For example, transportation systems have some reproducibility but will vary substantially by site.

The second quality of a technology is the *degree to which research, development, and testing* can reduce *uncertainty* about the likely outputs to be associated with a particular set of inputs. Designing and testing prototype models of automobile engines can yield high-confidence estimates of the performance of the engine. Tests of curriculum materials, on the other hand, yield only low-confidence estimates concerning the performance of those materials because of the weak theory upon which they are based and the variability of the inputs to the education process. If the uncertainties surrounding the relationship between the inputs and outputs of a technology have been substantially reduced prior to its incorporation as a demonstration, we will refer to the technology as being well *in hand.*

“Jan Chaiken, What is Known About Deterrent Effects of Police Activities, The RAND Corporation, P-5735-1, July 1977.

The Institutional Environment

A demonstration will result in a number of outcomes. Some of these will simply be what we have referred to as outputs of the technology associated with an innovation; others will be associated with the impacts that the use of the innovation has upon the environment, the behaviors of groups of citizens, or the employment in a community. A major reason for conducting a demonstration project is to improve knowledge concerning the effect of using the innovation on these outcomes.

The context in which the demonstration is carried out determines the scope of relevant outcomes. The needs and interests of the target audiences determine the specific outcomes measured. If, for example, the demonstration is intended to influence local police departments to adopt and use a new piece of equipment, the outcomes examined are those that are important to officials in these departments. The choice of a site or sites should include operational environments that are similar to the sites of most potential adopters. If the demonstration is intended to aid in the congressional debate concerning a new welfare system, it should be designed to address questions that Congress and its constituents consider important.

Thus, the relevant scope of outcomes for a demonstration is determined by the institutional environment in which it will be implemented. This environment encompasses the collection of organizations and the linkages among those organizations that are involved in selecting and implementing the innovation being demonstrated. The developers of the innovation, ultimate users, regulatory bodies, markets, and the Federal agencies that fund the demonstration are components of the institutional environment. The concept of a "technology delivery system" suggested by Wenk and that of a "selection environment" used by Nelson and Winter are roughly equivalent concepts.[9]

The institutional environment has importance to Federal officials for two reasons. If the Federal Government were contemplating using a demonstration to help determine the worth of a policy or the desirability of promoting the use of a particular innovation, the relevant scope of outcomes as set by the institutional environment would determine the inputs and outputs that must be measured to make credible inputs to the policy process. If, on the other hand, the Government were considering a demonstration to promote the use of an invention, the institutional environment would be the medium in which the use would take place; the important actors and communications links in this environment would be the critical determinants of the way in which the innovation is adopted and used.

The basic proposition about institutional environment that emerges from the literature is that innovation is strongly affected by the nature and the workings of the institutions in a policy sector. There are some familiar examples that help to clarify this point. In the area of national security, it is widely believed that the development, procurement, and development of new weapons systems is facilitated because the Federal Government is the sponsor of the relevant R&D, the buyer of the R&D product (usually a weapons system), and the user of that product. Even though the institutional environment in the national security area is complex, the dominant position of the Federal Government simplifies the process of innovation relative to other areas involving intergovernmental or public/private relationships.[10]

A second example is that of the Bell System. Within the framework of the American Telephone and Telegraph Company are the Bell Laboratories, the R&D organization; Western Electric, the production organization; and the Long Lines Division and the operating telephone companies, the organizations providing service. Thus, institutions within the AT&T organization are specialized in their functions, yet they are highly integrated concerning the manner in which each plans its operations and the ways in which each transfers the information or products to the others. It is argued by the Bell System, and believed by many, that this complex group of in-

'See Edward Wenk, Jr., "The Social Management of Technology," in John E. Mock (cd.), Science for Society, proceedings of the National Science Conference held at Atlanta, Ga., Oct. 12-14, 1970; The Committee on Public Engineering Policy, National Academy of Engineering, Priorities for Research Applicable to National Needs, report to the National Science Foundation, Washington, D. C., 1973; Arthur A. Ezra, "Technology Utilization: Incentives and Solar Energy, " Science, Vol. 187, Feb. 28, 1975, pp. 707-713; Richard T. Nelson and Sidney G. Winter, "In Search of Useful Theory of Innovation, " Research Policy, Vol. 6, 1977, pp. 36-76.

'"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.

stitutions, tied together as they are, facilitates the generation and diffusion of new communications technologies.[11]

A third example is found in the agricultural sector. The U.S. Department of Agriculture (USDA) has developed an institutional system over an extended period of time that is thought to be quite effective in ensuring the flow of innovation in agriculture. The USDA directly supports a national laboratory, four regional laboratories, and satellite research laboratories through the Agriculture Research Service. Through the Cooperative State Research Service, it finances research jointly with the States in colleges of agriculture and State experiment stations across the country. The Agricultural Extension Service, funded jointly by Federal, State, and county funds, supports the agricultural extension agents who are responsible for the dissemination of R&D results to prospective users and the needs of users to the research system. Thus, a strong system need not be centralized.[12]

These three examples illustrate relatively well-developed institutional environments. In contrast, consider the elementary and secondary education system. The National Institute of Education, the National Science Foundation, and the Office of Education provide funds at the national level. Fifty State departments of education assume a variety of stances toward promoting the use of new innovations in local school districts. Most education costs are for personnel. Training professionals in the school system is mainly the province of a large number of teacher preparation colleges that are not widely known for their interest in or conduct of R&D activities. Decisions concerning the adoption of new curriculum materials vary widely among States and localities. A beleaguered and embryonic network of R&D centers established by the Office of Education over a decade ago has failed to achieve notable successes. A persistent hostility exists between the practitioner community and the research community, which makes it difficult for communications to occur between them. The textbook manufacturers place little reliance on systematic materials development and testing. The components of the institutional environment are unevenly developed, poorly linked, and frequently in disagreement over the process of change in the schools.[13]

An important contributor to the nature of the institutional environment is the degree of consensus that exists concerning the appropriate Federal role in a particular policy area. In chapter II, we briefly sketched the evolution of the Federal role in a number of policy areas. In areas such as national security or agriculture, a strong Federal role is viewed as legitimate and is generally accepted and understood by the elements of the institutional environment. Similarly, there is fairly general agreement concerning the limits of the Federal role in promoting the use of basic research. However, in many areas of domestic policy and in energy policy there is considerable debate over the appropriate Federal role.

The strength of the rationale for Federal involvement in these "mixed responsibility" sectors varies substantially; more importantly, it is subject to a great deal of controversy. The involvement of the Federal Government in these sectors has come about because important political constituencies have felt that the performance of these sectors was inadequate for the needs of the country. For example, the Federal Government entered the health care financing area because the health needs of the elderly and the poor were not viewed as being adequately addressed by the existing Federal policy in these areas. State and local officials, whose operations are being curtailed by Federal activities, see Federal officials as interfering in their legitimate policy responsibilities. When demonstrations become a tool to further controversial Federal policies, their legitimacy is questioned.

This problem is exacerbated by increasing pressures from Congress and the public to take results of publicly supported research "off the shelf" and put them into practice. While we may question whether sufficient R&D exists "on the shelf" to justify this concern, the pressure has led Federal R&D agencies to promote the commer-

[11] See H.W. Bode, Synergy: Technical Integration and Technological Innovation in the Bell System, Bell Laboratories, Murray Hill, N. J., 1971.

[12] A. Hunter Dupree, Science in the Federal Government, Harvard University Press, Cambridge, Mass., 1957.

[13] For a description of the education R&D system and the institutional environment which surrounds it, see The Status of Education Research and Development in the United States: 1976 Databook, The National Institute of Education, Washington, DC., 1976.

cialization and use of R&D activities and to provide demonstration projects with a promient role in this effort. The Federal Government must choose specific technologies for demonstration. These demonstrations will be chosen to advance Federal policy goals, ghals that maybe in conflict with those of State and local authorities or the private sector. In the situation where such conflict exists, the probability of success in promoting the use of a new innovation or technology will be low.

Another general factor that shapes the institutional environment is the extent to which an R&D tradition is a part of the operations of a policy sector. For example, in the military sector, in civilian technology, in agriculture, or in parts of the health sector, there is a long tradition of using R&D results to improve performance. In contrast, R&D in support of the improvement of the criminal justice or educational systems is relatively recent. In the absence of a tradition of using R&D and of training emphasizing the utility of R&D to important actors within a sector, it is unlikely that R&D and demonstration will play a major role in the near future.

Judging the Development of Institutional Environments. -The examples and discussion suggest criteria by which to judge the degree of development of these institutional environments. A well-developed environment might have the following attributes:

- A set of institutions necessary for the entire process of research, development, commercialization, and application.
- Established, agreed-upon roles and responsibilities of these institutions (including the Federal role).
- Communication paths among these institutions along which information critical to the R&D planning, utilization, commercialization, and innovation process can flow.
- Communications among institutions that are sufficiently frequent and strong to facilitate the movement of an innovation into utilization.
- Well-developed criteria at each stage of the innovation process for evaluating the desirability of the movement from one stage to the next.

These criteria for a developed institutional environment emphasize qualities that are likely to lead to routine and continuing innovative activities. Equally important, sectors that have the degree of development implied by these criteria are likely to have developed a consensus about the relevant scope of outcomes by which a prospective innovation should be evaluated; conversely, in less developed institutional environments, there is likely to be considerable disagreement over the outcomes of greatest importance.

The Interaction Between Technology and the Institutional Environment. - An appreciation of these factors and the manner in which they affect the success of demonstrations can be gained by an examination of several specific examples.

Central power generation can be contrasted with solar heating and cooling, a decentralized form of "power" generation. In both cases, the technologies seem reproducible. We know a great deal about their performance and are confident that we can learn more. Some aspects of these technologies are currently well in hand while others require further development. However, these two technologies are used in two quite different institutional environments.

Central power station technologies are developed and used in an environment where the suppliers are known; the regulatory apparatus is in place; and the market is orderly. " In contrast, solar heating and cooling is being developed and used in a less developed environment; its application is controlled by hundreds of building codes. The industry that supplies the technology is new and unstructured. Financial and tax policies for installations are not yet routinized. Regular sources of maintenance are not yet applicable. Suitable criteria for making decisions about whether or not to invest in the technology are not yet widely agreed upon. Thus, while we are confident that we know or can know a great deal about the performance of the technology, the institutional environment for facilitating the

"This institutional environment is less well developed now than several years ago because of the advent of both energy and environmental concerns. These concerns have resulted in new and as yet incompletely specified roles for the Federal Government. The regulatory structure governing powerplants has been elaborated and new groups have joined in powerplant design decisions Still. according to the criteria presented in this section, central power generation occurs in a developed institutional environment.

application of technology is not well developed. 15

Day care in industrial and community settings provides an example of how institutional environments of differing levels of development can shape the relevant scope of outcomes for demonstration projects. There is little agreement among child care specialists concerning the levels of inputs. competencies of care givers, and types of activities that will produce various outcomes in children in day care settings. The standards that should govern day care financed by the Federal Government have been subject to vigorous debate for a number of years. There is also considerable disagreement over what constitutes the appropriate measures of outcome for day care.

In the public sector, day care is typically provided by a variety of institutions for the benefit of the children, as well as the parents. Accreditation for day care centers varies substantially among jurisdictions. The standards for training of care givers are highly variable. Nationally, the level of subsidization for day care and the restrictions placed upon the operation of programs that receive subsidies are still matters of debate. The institutional environment is poorly developed. The relevant scope of outcomes is broad. The technology has low reproducibility.

Several years ago, as a result of the general concern over extending day care to more parents and the pressures from feminist and other groups, a number of industrial firms experimented with day care. These firms provided day care to small groups of their own employees on a trial basis .1' The firms quickly decided that the relevant outcome of the day care they supported would be reduced absenteeism and lower turnover among their personnel. These day care centers met existing local standards for good day care but did not consider provision of education to children as a relevant goal. The demonstrations suggested that relatively few parents found day care provided at the work site as desirable or no improvement in turnover or absenteeism. The idea seems to be largely abandoned. 18

In this case, within an industrial setting there was agreement over the outcomes that were important. Responsibility for the demonstration was clearly assigned. And there was general agreement over the meaning of the outcomes of the demonstration among the potential providers of industrial day care. The institutional environment was well developed. Moreover, the technology associated with these outcomes was reproducible. While there may be no reproducible means of providing day care that maximizes cognitive growth in children, there is no problem in creating day care centers that meet specified (input) standards.

"For an interesting discussion of institutional environments in general and that surrounding solar heating in particular, see Arthur A. Ezra, "Technology Utilization: incentives and Solar Energy, " science, VOI. 187. Feb. 28? 1975, pp. 707-713.

'[6]A brief history of the controversy surrounding Federal support for day care is contained in Gilbert Y. Steiner, The Children Cause, The Brookings Institution, Washington, D.C. , 1976, pp. 14-35.

"Using our terminology, they conducted policy-formulating demonstrations.

'*''Minding the Kid, Frustrating for Companies," New York Times, Sept. 11, 1977, p.F9.

Chapter IV

FACTORS AFFECTING THE SUCCESS OF DEMONSTRATIONS

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The previous section developed a conceptual framework with which to discuss factors that affect the success of both policy-formulating and policy-implementing demonstrations. In this chapter we advance several propositions concerning the determinants of success of demonstrations and assess the evidence contained in the literature concerning these propositions. As in the last chapter, our emphasis is on the use of demonstrations as a logical step in an R&D process. Because the experience with policy-implementing demonstrations is rich, we begin our discussion there.

Factors Affecting the Success of Policy-implementing Demonstrations

Given the manner in which we have defined policy-implementing demonstrations, the criteria by which to judge their success is straightforward: did the demonstration result in the diffusion and use of the demonstrated innovation in other sites? An innovation may be an industrial process, a new product, or a program design. In the course of the innovation's diffusion to other sites, it may be expected to change somewhat in response to the needs and interests of that site. It is a matter of judgment as to when the innovation has sufficiently changed that it should no longer be viewed as the same innovation.

The analysis above together with the literature that we have reviewed suggest that a number of propositions concerning the use of demonstrations that should guide policy makers at the Federal level:

- Implementation demonstrations having technologies with low reproducibility are unlikely to lead to successful diffusion.
- If a technology is well in hand, a policy-implementing demonstration has a higher probability of success than if the technology is not well in hand.
- Implementation demonstrations that are conducted in a well-developed institutional environment where there is a clearly accepted Federal role are more likely to achieve diffusion success.
- An innovation requiring cooperative action among elements of an institutional environment will be less likely to diffuse than one with an application within the scope of a single institution.
- User need, as exemplified by non-Federal initiative and cost/risk sharing, is an important factor in the success of policy-implementing demonstrations.
- Lack of time constraints and operational flexibility are important to the success of policy-implementing demonstrations.

Each of these propositions is discussed in detail in the following,

Technologies With Low Reproducibility

If the technology is perceived as being nonreproducible, a demonstration incorporating that technology will not be likely to lead to successful widespread diffusion of similarly performing processes or projects because potential users will not be able to reproduce the demonstrated process. Projects incorporating nonreproducible technologies may provide ideas to other potential users; they may suggest pitfalls to avoid in 1 plementing a project; they may even provit equipment and materials that can be used b others. But they seem unlikely to lead to similar operations in other locations.

Available evidence is consistent with this proposition. Education, for example, possesses technology with low reproducibility. In their study of Federal programs promoting educational change, Berman and McLaughlin found no significant diffusion of the innovative projects supported under the programs. Their study showed that (1) local staff preferred to develop their own material, even when prepared material was available; (2) successful projects that differed substantially from usual practice were viewed as nonreplicable by staff from other locations; (3) rather than search for alternatives, local staff preferred to solve problems by using information already known to local personnel; and (4) local personnel tended to view their own site as unique. As a consequence of these characteristics, the Change Agent study hypothesized that significant innovation could be implemented only through a process of "mutual adaptation. " It reported:

> The initial design of an innovative project must be adapted to the particular organizational setting of the school, classroom, or other institutional hosts, and, at the same time, the organization and its members must adapt to the demands of the project. Many educational innovations may fail to have desirable effects because the project is not adapted to the institutional setting or vice versa during the implementation stage.2

This model of change requires unique interaction of the innovation with staff at each potential adoption site. Given such a requirement, it seems unlikely that exemplary projects at selected demonstration sites will be replicated elsewhere.

If diffusion is no longer a relevant success criterion for such demonstrations because a unique implementation of a technology with low reproducibility is required at each site, Federal policy makers should consider redefining the goals of a program supporting such projects. Perhaps these programs should consciously seek site-specific development for use mainly at the project site. In such cases, decisions to initiate a project should be evaluated on the basis of the costs and benefits associated with an individual adoption. The use of the term "demonstration project" would appear misleading for this type of project. ' We have referred to this type of program as *subsidized local development.*

In a number of areas, innovative technologies of substantial reproducibility are used in a larger "system, " where adaptation of the innovation may occur. Examples include mass transit, law enforcement hardware, and mining. Success of demonstrations where such adaptation can take place depends in part upon the perceived similarity of the environment in which the demonstration is conducted to that of the potential adapter.

Two examples from mass transit illustrate this point. The Shirley Highway Express Bus Lanes in the Washington, D .C., area used conventional buses and highway and street lanes exclusively designated for buses. The project measured actual ridership and thus avoided the theoretical debates in the mass transportation community about the relative importance to potential commuters of trip time, waiting time, transfers, or comfort. The success of the system in attracting commuters and in showing that the demonstration results are relevant to other metropolitan areas with radial commuting corridors has led to diffusion of the concept to other cities. "

In contrast, the Personal Rapid Transit (PRT) demonstration which, as we shall note, experienced many technical difficulties, was demonstrated in such a specialized situation that it seems unlikely that it would have been persuasive even in the absence of technical problems. This system, involving unattended small vehicles operating on a fixed track, was used to connect parts of The University of West Virginia in Morgantown. It seems unlikely that the conditions prevailing at this university campus would be sufficiently similar to other contexts for this innovation to be persuasively demonstrated to city planners. The demonstration did not provide credible predictions of the relevant outcomes.

The existence of replicated projects may also be important to the diffusion of innovations using technologies with low reproducibility. Yin discusses this issue with respect to innovation in local law enforcement. In considering the Kansas City Preventive Patrol Experiment as an exam-

'Paul Berman and Milbrey Wallin McLaughlin, Federal Programs Supporting Educational Change, The Findings in Reuiew: Vol. IV, The RAND Corporation, R-1589/4-HEW, April 1975, p. 1, hereafter referred to as the Change Agent study.

'Ibid, p. 6.

'It should be noted, however, that experiences with this type of program are not encouraging. The Change Agent study found that only 5 percent of a sample of such local development projects resulted in permanent incorporation of the project.

'Cheryl D. Hayes, "Toward a Conceptualization of the Functions of Demonstrations, " in Thomas K. Glennan, Jr., (cd.), Studies in the Managment of Social Research and Development, The National Academy of Sciences, Washington, D. C., forthcoming.

pie, he cautions that “findings . . . are not facts.’” Unless successful results are experienced at multiple sites, they may not be credible to potential adopters. Diffusion of intermediate strength technology innovations in the absence of such replications is not likely.

Technology That Is Well in Hand

The degree to which a technology is in hand will affect the success of policy-implementing demonstrations. In projects using technologies that are not well in hand, managers must concentrate on developing and improving the technology. The rhythm of the project will reflect the technical needs of development activities. On the other hand, the concerns of the adopters will frequently focus on questions such as the reliability of the process, the administrative feasibility of implementing the process with the manpower available at local sites, and the operating costs of processes under routine conditions. If the technology is not well in hand, evidence concerning these latter issues will be more speculative and less clear. The demonstration may well be less than effective in persuading adopters to make a decision to implement a new innovation.

The Federal Demonstrations study provides persuasive evidence that the lack of technology well in hand adversely affects diffusion. This study found little or no diffusion in any of the demonstrations for which there was high technical uncertainty. Uncertainty was considered high “when the technology has not previously been prototype or field tested; or when basic problems with the technology are known to exist, and techniques for dealing with them are not clear at the time of the demonstrations. [6] With one exception, all of the examined demonstrations of technologies with medium or low uncertainty achieved at least some diffusion success unless there were institutional problems. [7] A possible explanation for this finding is that the lack of uncertainty enables a realistic appraisal of the prospects for successful implementation. As a consequence, technologies that do not possess some advantage over the status quo are not demonstrated.

The exception to this pattern—a demonstration of a seawater desalination process in Freeport, Tex.—is instructive. The demonstration involved testing a large-scale version of a desalination process previously tested only in a pilot plant. The project was classified as having medium preproject technological uncertainty. The process required significant development work during the course of the demonstration, which resulted in important improvements in performance but also in interruptions in plant operations. At the end of the demonstration, the technology could be considered well in hand. However, potential adopters of desalination plants mistakenly perceived these instructions at the Freeport plant as an indication that the desalination process was unreliable. These potential adopters failed to understand that the interruptions were necessary for technological development work to occur.[8]

The PRT demonstration illustrates how the implementation of an undeveloped technology affects the operational results and the innovation’s diffusion. The major leap in technology incorporated in the project led to rapid escalations in cost, ultimately to a cost of over $60 million. To keep costs down, the system was modified and curtailed, and the resulting system provided little useful data on the possible spacing of vehicles, the relative attractiveness of PRT to private transportation, or other important measures.[9]

The Freeport desalination and the PRT cases illustrate the importance of considering an alternative to a demonstration when a technology contains some elements of uncertainty. When high technological uncertainty exists, a full-scale test at a test-bed facility should be considered. This test of the technology at the development-oriented facility would ease the development of engineering solutions to technical problems by removing real-world operating constraints.

[5] Robert K. Yin, R&D Utilization by Local Services: Problems and Proposals ~or Further Research, The RAND Corporation, R-2020 -DOJ, December 1976, p. vii.

‘Federal Demonstrations. p. 31.

‘Medium technological uncertainty was considered to exist when technology had been tested at a lower scale but uncertainties remained about performance at near-commercial size or where uncertainties remained concerning performance of a new configuration of components. Low technological uncertainty characterized projects using existing components in configurations similar to previous use. See Federal Demonstrations, p. 31.

“William F. Hederman, “Saline Water Conversion Plant,” in Federal Demonstrations: Case Studies, pp. G 1-G46.

‘Federal Demonstrations, pp. 137-138.

Demonstrations in Well-Developed Institutional Environments

Areas with well-developed institutional environments pose relatively minor problems for Federal policies governing the use of demonstrations. Their very development means that the innovation system is working well and probably on a continuing basis. Mutual agreement exists concerning when demonstrations are appropriate. Sponsors and performers of demonstrations will know which actors to involve and those actors will understand the needs and patterns of success within the policy area.

Poorly developed institutional environments seem more likely to give rise to the type of goal and value conflicts among the actors that have been mentioned frequently in earlier sections of this report. The absence of close ties among the actors, lack of important institutional entities, or the lack of consensus over the appropriate means of bringing about and diffusing innovations all lead to the possibility of such disagreements over goals and values.

The empirical literature tends to support this proposition. The Federal Demonstrations study found that all demonstrations that examined what had taken place in well-developed institutional environments had achieved at least some diffusion success.

Moreover, the evidence indicates that the participation of the components of the institutional environment is also important to diffusion success. The Federal Demonstration study found that only one demonstration project that excluded some active components of the institutional environment was diffused.

The exception to the observed pattern illuminates this proposition. A demonstration of mechanized refuse collection aimed at reducing labor costs through smaller collection crews was a striking application success. The service, provision of a mechanism to improve truck refuse collection, was cost-effective and received strong public approval (exceeding 90 percent). However, the mechanism was designed by city personnel, and no garbage-truck outfitting firm could be found to market the new truck. Consequently, the diffusion observed was piecemeal and not self-sustaining, a disappointing result for an innovation based upon a reproducible technology that was successful in its initial application.11

The innovative behavior of local governments suggests the existence of goals other than those that would normally be emphasized in the planning and execution of a demonstration project. For example, in an investigation of technological innovation in State and local services, Yin and his colleagues found that evidence on the trial and adoption or rejection of new technologies supported two differing interpretations of how local agencies operate, One model, termed a problem-solving model, involves local identification of problems and a search for means to solve the problems. The second emphasizes conditions of bureaucratic self-interest that govern the innovations to be incorporated. Yin et al., in a study of innovation, suggest that both models of innovative behavior may operate at the State and local level.

The important point to note in these findings is that demonstrating a new technology is not an effective way to influence local problem solving and the bureaucratic process. The character of local innovation seems to spring from the characteristics of each locality and the needs that they perceive, rather than from the opportunities presented by a demonstrattion project. This discrepancy may be part of the reason that Yin's analysis found no statistically significant relationship between a variety of Federal policies and successful incorporation in local innovation. *[3]

Requirements for Cooperative Efforts

An innovation requiring cooperative action among elements of an institutional environment will be less likely to diffuse than one where its application is within the scope of a single institution. Innovations can be significantly mismatched to the institutional environment to which they are intended to apply. In such instance, even if the environment is developed and the technology is free of uncertainty, diffusion may not take place.

'"Federal Demonstrations, pp. 51-53. The one exception to this finding appears to have been examined too soon after the demonstration for any meaningful assessment of diffusion to have been made.

"Federal Demonstrations, p. 96.

'[2]Robert K. Yin, Karen A. Heald and Mary E. Vogel, Tinkering with the System, Chapter 5, Lexington Books, Lexington, Mass., 1977.

'[3]1 bid., Chapter 6.

The regional emergency medical service is a case in point. The capability of specialized systems of emergency medical care to save lives has been demonstrated. Necessary equipment, personnel, and organizational procedures are known and local governments and communities seem to appreciate the need for such services. Nonetheless, the development of these systems has been sporadic.

A major reason for this sporadic development is that the appropriate scale for such operations exceeds the scale of most local political jurisdictions and hence requires cooperation across jurisdictional boundaries. Funds must be raised from a variety of jurisdictions, central control and management must be agreed upon, and a variety of hospitals and other medical providers must cooperate. Because this type of joint effort is difficult to bring about, the diffusion of the innovation is slow and uncertain even though there has been Federal funding to support it.

The use of cable telecommunications to provide social services seems likely to face similar problems. Effective use of this medium will require cooperation among a number of social service and regulatory agencies as well as several levels of government. These agencies have disparate and conflicting goals and frequently resist efforts of other agencies to enter their areas of specialization. Diffusion of cable technology for these uses will not occur easily.

User Need

A serious commitment to the innovation by the performer is important to the successful operation of a demonstration. Both the Change Agent study and the Federal Demonstrations study found non-Federal initiative to be important to demonstration success. The Change Agent study's description of the two types of project initiation encountered—opportunism and problem resolving—illustrates the problem well:

> Projects generated essentially by opportunism seemed to be a response to available funds and were characterized by a lack of interest and commitment on the part of local participants—from district administrations to classroom teachers. As a result, participants were often indifferent to project activities and outcomes, and little in the way of serious change was ever attempted—or occurred.
>
> The problem-solving motive for projects emerged primarily in response to locally identified needs and was associated with a strong commitment to address these needs. Federal funds were viewed as a way to support the local solution—one which often broke new ground in local educational practice. 16

Cost sharing by non-Federal participants is an indication of interest. The Federal Demonstrations study found that demonstrations with large shares of Federal funding (more than 90 percent) had a poor chance of diffusion success.

The form of the cost sharing is also important. For example, the share of costs for projects at the State and local levels is frequently small and in the form of contributed space and services. In such instances, the type of opportunism that the Change Agent study notes can easily occur. It seems likely that larger contributions, involving staff and financial resources, will assure that at least some consideration is given to whether the demonstration is consistent with the interests of the local jurisdiction. For example, the mechanized refuse collection demonstration that was cited earlier involved contributions of nearly 40 percent of the cost by the city of Scottsdale, Ariz.

When the intent of the demonstration is to promote the commercialization of a technology by the private sector, a variety of forms of cost sharing are possible. A close-ended contribution can be made as was the case with the Atomic Energy Commision's Power Demonstration Reactor Program. 18 Loan guarantees can be provided as was contemplated in the proposed synthetic fuels legislation. 19 The demonstrating firm

"The Comptroller General of the United States, Progress, but Problems, in Developing Emergency Medical Service Systems, Washington, D. C., July 13, 1976.

"For an interesting discussion of this point see William A. Lucas, "Social Service Applications of Electronic Abundance," in Forrest Chisman and Glen Robinson (eds.), Communications for Tomorrow: Policy Perspectives for the Future (tentative title), Aspen Institute, Washington, DC., forthcoming.

"Change Agent study, p. 9

"Federal Demonstrations, p. 96.

18 Federal Demonstrations. Case Studies, pp I-55 and 1-56.

"U.S. Congress, House. 94th Cong., 2d Sess., Committee on Banking, Currency and Housing, Loan Guarantees jor Demonstration of New Energy Technologies, report to accompany H.R. 12112, Washington, D. C,, June 1976.

(or consortium of firms) can make a fixed contribution and the Government can support the remainder, as was proposed in the Clinch River Breeder Reactor Demonstration .'" Tax subsidies may be provided for specific types of investments. The Government may guarantee the price of the output of a particular plant. Detailed examination of these various methods of finance is beyond the scope of this report, and in any case must be made on a case-by-case basis. Nonetheless, the literature provides a few guiding principles.

The MIT Energy Laboratory Policy Group, in examining policies for commercialization of energy technologies, suggests three guidelines:

1. Subsidies for demonstration projects should simulate the workings of the normal market and should be as small as possible.
2. The mechanism for providing the subsidy should ideally provide managers with a circumstance much the same as that in the unsubsidized case. In particular, it should be neutral with respect to the choice of inputs such as capital, labor, transportation, and maintenance.
3. The financing mechanism should reveal the full costs of the program and the detailed cost performance of the individual technologies. Loan guarantees are cited as poor means of achieving this objective because the degree of subsidy is not obvious. 21

These guidelines suggest simple, obvious cost arrangements designed to elicit a commitment to the effort by the private-sector firm.

Federal Demonstrations suggests that at the beginning of planning for a demonstration project, a survey of possible participants should be made to determine their willingness to participate in the demonstration. Lack of willingness to make substantial contributions to the cost may well indicate that technological uncertainty is too high to proceed with a demonstration, that market demand is weak, that costs are high, or that institutional factors or side effects are likely to inhibit the use of the innovation .22 Thus, the Federal Demonstrations study suggests that the willingness to share costs may be an appropriate "market test" for the demonstration of a new technology.

This willingness cannot always be used as an indicator of commitment. If the problem to which the demonstration is addressed arises because of State or local inattention or indifference, a strong cost-sharing requirement may merely provide a convenient excuse for that Government to avoid response. There is no easy solution to this dilemma.

Time and Operational Flexibility

In the Federal Demonstrations study, not one demonstration that proceeded under strict time constraints achieved any diffusion success. It is also worth noting that none of these demonstrations produced the information necessary to make an adoption decision, and only one was successfully adopted at the demonstration site. These time constraints had little to do with interest in diffusing the innovations. They were primarily generated by other policy and political needs .23

Operational flexibility allows the project performers to react to unanticipated events—either to avoid or recover from negative events or to take advantage of positive ones. Every demonstration encounters some unexpected situations of varying importance. One reading project examined in the Change Agent study encountered a freeze on the use of outside contractors who were to print a locally developed test, the printing of the wrong version of the test by student printers, and a citywide teachers' strike .24 In another case, an attempt to extend a classroom organization project to a junior high failed. By completely redesigning the program consistent with the elementary project but using different techniques, a "significant degree of success" was achieved .25

[20] 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, pp. 117-120.

"Policy Study Group, Energy Laboratory, Government Support for the Commercialization of New Energy Technologies, An Analysis and Exploration of the Issues, MIT, Cambridge, Mass., November 1976, p. 11.

"Federal Demonstrations, p. 71.

[23] 1bid, pp. 53-54.

"Peter Greenwood et al., Federal Programs Supporting Educational Change: The Process of Change, Vol. III, The RAND Corporation, R-1589/3-HEW, April 1975, p. 43.

"Ibid, p. 44.

The Change Agent study found that attempts to prescribe management techniques were "usually counterproductive, leading to nonimplementation or cooptation. "[26] The Federal Demonstrations study does not dwell on detailed management procedures for the hardware demonstrations except to state that "onsite management was generally effective, " meaning that project management was not a major source of trouble in the cases studied .[27]

Factors Affecting the Success of Policy-Formulating Demonstrations

In comparison with policy-implementing demonstrations, there has been relatively little examination of the success or failure of policy-formulating demonstrations. In part, this is because there have not been many such demonstrations. More importantly, however, the complexity of the policymaking process makes it difficult to trace the use of information produced by such demonstrations.

The making of policy seldom conforms to the models of rational decisionmaking that are presented in the literature. At the Federal level, policymaking extends over a long period of time and often includes loosely coupled actions at several levels of Government. For example, debate over the Nation's welfare system has been going on for decades, with additions from time to time of new information or new calls for national concern. Perceptions concerning the fiscal health of cities have shaped the nature of the program solutions that have been advanced. The almost inadvertent expansion of programs such as food stamps changes the need for welfare reform. Determining the role that a particular piece of information plays in shaping a particular policy is virtually impossible,

Policymaking consists of identifying problems, searching for possible courses of action, articulating and evaluating these courses of action, and choosing one or a combination of the options. These are not necessarily sequential events, however. The definition of the problem may take place as a committee of Congress or a legislative drafting group articulates and evaluates proposed programs. A possible solution may be shaped by policy actions in quite different problem areas. The identification and articulation of policy alternatives may occur in adversary proceedings or as the result of patient analytical staff work.

Demonstration projects may make contributions to virtually all steps of the policymaking process. The most obvious contribution is the articulation of the consequences of adopting a particular policy. Estimates of the costs, performance, and unanticipated effects of a policy or program may be obtained. However, the process of designing the project may help to clarify the nature of the problem and therefore to define the objectives of a potential policy. Conducting a demonstration may be a means of advocating the consideration of a policy alternative by groups or programs that have the interest and resources to do so. It is even possible to imagine that an array of projects which embody the various policy or program alternatives could provide decisive information for choosing among policies.

Of course, many factors affect the outcome of a policy debate besides the predicted performance of the policy itself. Distribution of benefits and costs among groups, regions, or industries may be important. The particular interests and values of policy makers in important positions will shape both the alternatives considered and the choices made. Crises or events that require immediate action may make quick decisions imperative. Consequently, it will be very difficult to provide sharp assessments of the success or failure of demonstrations that seek to contribute to the policymaking process.

The distinction between policy-formulating and policy-implementing demonstrations was originally made to categorize the purposes of social demonstrations. 28 Social experiments such as those dealing with housing allowances, income maintenance, health insurance, and utility rate structures fit the description well. Other social service and education projects can be identified that are tested in realistic environments to determine if they should be put into effect in large-scale programs.

[26] *Change* Agent study, p. 26,

"Federal Demonstrations, p. 58.

"Cheryl D. Hayes, "Toward a Conceptualization of the Function of Demonstrations," in Thomas K. Glennan, Jr., (cd.), Studies in the Management OJ Social Research and Development, the National Academy of Sciences, Washington, D. C., forthcoming.

While the concept of a policy-formulating demonstration has not been used with more technical hardware projects, it is clearly applicable. Within the military systems, tests of new aircraft or weapons systems frequently provide a basis for decisions as to whether or not to procure the system and begin large production runs. A number of demonstrations have also been carried out as an aid to formulating regulatory policy. For example, the aircraft industry and the airlines under National Aeronautics and Space Adminillustration (NASA) sponsorship and with the participation of the Federal Aviation Administration (FAA) designed and tested quieter engines to reduce the noise at airports (Project Refan). Data on costs and performance were obtained that have helped to shape FAA policy in this area. " The detailed observation of Dunes airport landings and takeoffs of the Concorde supersonic aircraft is a demonstration to help establish appropriate noise level standards for such aircraft.

The complex nature of most policy decisions precludes the sharp designation of criteria for success or failure of a demonstration. Instead, we suggest two attributes of a demonstration that would seem to be necessary for success:

- Perceived quality of the information provides,
- Perceived relevance of that information to the policymaking process.

We emphasize the term "perceived" because it is difficult to specify intrinsic qualities of demonstrations that can be associated with all successful demonstrations. "Success" in the creation of new policy is likely to reflect the political resolution of the value conflicts in question, and thus can be only partially related to the outcome of a demonstration project.

Perceived Quality

Policy makers in varied positions or at different times will prefer different forms of evidence. For example, during the late 1960's and early 1970's, many Federal executives pushed for improved experimental designs for demonstrations. It was hoped that the use of such designs would make the results of the demonstrations more reliable and generalizable. Frequently, these policy makers also sought independent evaluations because of their fear that evaluative information provided by the performers of the demonstrations themselves would be subject to self-serving bias. The observations of program operators, State and local policy makers, or industry executives were viewed as unreliable and insufficient bases upon which to make policy.

Other executives and many Members of Congress expressed quite different preferences. They preferred the input of trusted colleagues or individuals who had provided useful and reliable information in the past. They sought information on a wider range of outcomes than was typically provided by scientific evaluation designs. They valued the ability to observe the actual demonstration, to talk with its managers and with clients of the project.

The preferences for different types of information will depend in part upon the background factors mentioned above. In areas where there is a tradition of R&D and where there is a belief in the strength of the technological base, higher quality scientific information will be important. The quality of the experimental design and the independence of the evaluator will be significant factors in the policy makers' judgment concerning worth of the information. In those areas where there is no such tradition or where the state of the technology is a matter of debate, more qualitative and impressionistic information may be preferred. Thus, these preferences are situation-specific.

Perceived Relevance

The relevance of the information depends upon three factors: (1) the centrality to the policy debate of the information produced by the demonstration, (2) the degree to which parties to the policy debate *jointly* perceive the evidence as valid, and (3) the timeliness of the demonstration relative to the policy debate.

The central issues of a policy debate may be difficult to predict. For example, the income maintenance experiments provide information on the labor force behavior of recipients of income maintenance payments. At the time these experiments were initiated, this information was expected to be a major issue in a debate on the desirability of establishing a widespread income maintenance system; indeed, in the early

"Federal Demonstrations, p. 161: Peter W. House and David W. Jones, Getting It Off the Shelj: A Methodology for Implementing Federal Research, West View Press, Boulder, Colo., 1977, pp. 232-234.

debates this issue was important. However, the debates have now continued for some 8 years and other concerns have become more important. Today concerns are expressed about the distribution of benefits among different classes of recipients and different areas of the country, the manner in which States will participate in the administration of the program, the degree to which benefit levels will vary by area of the country, and the effect the program will have on employment programs. In part, this shift can be attributed to Congress's recognition that political issues surrounding welfare reform relate to the distribution of costs and benefits. In part, however, the reason for the receding relevance of the information provided by the income maintenance experiments may be that their findings were such as to reduce the concern on the part of the lawmakers and the public that there would be massive withdrawals from the labor force.

The success of a demonstration in aiding a policy debate should depend upon the joint acceptance of the validity of the information by participants in that debate. If, for example, one goal of a demonstration is to determine the environmental effects of a new process for the production of synthetic fuel and if both the promoters of the innovation and the interested environmental groups do not agree upon the pollutants to be measured and the means of measuring them, the evidence produced by the demonstration and the policy debate is likely to be less useful than would otherwise be the case. In another context, one problem—although not necessarily the most significant one—in determining the efficacy of Laetrile in the treatment of cancer patients is that agreement among proponents and opponents as to what constitutes a fair test is difficult to conceive.

The timing of demonstrations also poses significant problems. Many policy decisions are made as a result of forces quite independent of the development and evolution of a technology. When a crisis arises, such as the OPEC oil embargo or the urban riots, policies will be formulated and implemented whether or not there is information from demonstrations or other classes of R&D that would affect those policies. Politicians in both executive and legislative branches have short time horizons. They stand for reelection at regular intervals or possess career progression patterns that place them in particular policy positions for short periods of time. Policies are often made in response to pressure from various interest groups. Because of the fluidity of the situation and because of length of time usually involved in the conduct of demonstrations, matching the results of demonstration activities to the policymaking process is troublesome.

The difficulty in matching the timing of demonstrations to decisonmaking varies among policies. Where the question is one of adopting and promoting a major technological device such as a new weapons system or a specific energy-related process such as the breeder reactor, the sensitivity of the policy to evidence concerning the performance of the device may be so widely appreciated that the policymaking will be paced by the evolution of the technological work. A policy-formulation demonstration in this case would set the timing for policymaking.

In contrast, in cases where the technology is clearly not perceived as central to the decisonmaking process, other imperatives that govern the policymaking process will take over. Consider again the income maintenance experiment: the underlying technology, the transfer of funds to individuals contingent upon their other sources of income, was perceived as being feasible from the beginning. The demonstrations focused on the work incentives, unanticipated outcomes, and administrative processes. These issues were not suffiently central to the policy debates that the executive branch or Congress felt the debate should await the completion of the demonstration.

This discussion leads us to advance two tentative propositions concerning factors affecting the success of policy-implementing demonstrations:

- The perceived relevance and usefulness of policy-formulating demonstrations will be enhanced when they are initiated and performed by agencies with close continuing ties with policy makers.
- Policy-formulating projects that give conscious attention to expected points of conflict in the policy debate and address these conflicts in their design will be more successful than those that are developed along the interests of just one party.

Continuing Close Ties With Policymakers

One theme pervades our discussion of factors affecting the success of policy-formulating demonstrations. The success of such demonstrations depends upon the styles and interests of relevant policy makers. Demonstrations initiated and managed by organizations that are closely linked to the policy maker are likely to reflect those interests.

All the cited examples of policy-formulating demonstrations have been initiated and managed by organizations that bore close relationships to executive branch policy makers. The social experiments have been sponsored and monitored by Assistant Secretary level offices of policy planning and evaluation. The regulatory demonstrations were carried out by the cognizant regulatory agency. We have reviewed no examples of policy-formulating demonstrations that have been supported by relatively independent research agencies such as the National Science Foundation or the National Institutes of Health. Thus, we cannot provide evidence to test this proposition.

Although a major portion of the policymaking process concerning the issues examined in these experiments will be associated with the development of legislation, Congress has generally played a minor role in the design of the experiments. Sponsors of demonstrations frequently do not relate closely to Congress. The housing experiments, although mandated by law, were implemented with little input from legislators. The income maintenance experiments were designed on the basis of executive branch perceptions of what the policy issues would be. The same was true of the health insurance experiment.

We have found two instances in which Congress mandated demonstrations to understand the effects of a proposed policy change. The 1972 amendments to the Social Security Act authorized a group of experiments and demonstrations: [30]

> to determine the relative advantages and disadvantages of various alternative methods of making payment on a prospective basis to hospitals, skilled nursing facilities, and other providers of services for care and services provided by them under Title XVII . . . including alternative methods for classifying providers, for establishing prospective rates of payment, and for implementing on a gradual, selective, or other basis the establishment of a prospective payment system.

Under this authorization, a number of demonstrations have been mounted; in addition, several existing State efforts to limit the rate of increase of hospital costs have been evaluated, which essentially made these efforts policy-formulation demonstrations .3*

In 1974, Congress authorized up to 20 experimental programs as a part of the Study of the Effectiveness of Compensatory Education Programs. The primary purpose of these programs was to determine the effects of changing the bases upon which compensatory education funds were allocated within a local education agency. Under this authorization, 13 districts are experimenting with policies such as using academic achievement rather than poverty criteria to allocate compensatory education funds. [32]

Including Points of Conflict in Demonstration Design

The making of policy frequently involves melding together a variety of conflicting views. This is particularly true for the policies made by Congress. As a consequence, we might hypothesize: policy-formulating demonstrations that give conscious attention to the expected points of conflict in the policy debate and address these conflicts in their design will be more successful than those that are developed along the interests of just one party.

Explicit and participatory processes for seeking the conflicting views were not apparent in the planning of the demonstrations we examined. However, in some cases, particularly those associated with the regulatory demonstrations, many of the interested parties directly participated in the conduct of the demonstration. In the case of the Refan engine, manufacturers, the regulatory

[30] Sec. 22 of Social Security Amendments of 1972.

[31] U. S. Department of Health, Education, and Welfare, Social Security Administration, Office of Research and Statistics, Research in Health Care Reimbursement, Spring/Summer 1976, Publication No. (SSA) 77-11901, Washington, D. C., 1976.

[32] National Institute of Education, Evaluating Compensatory Education, an interim Report on the NIE Compensatory Education Study, Washington, D. C., Dec.30, 1976, Appendixes A and B.

agency, and the airlines all participated, and the evidence from the demonstration does not seem to have been a matter of dispute.

Kash et al., in a study of needed energy R&D, proposed that many of the demonstrations of energy supply technologies should be viewed as means of obtaining evidence to resolve disputes among concerned groups such as the environmentalists and industry.[33] It certainly seems desirable to assure that the concerns of various parties in a dispute over the desirability of a course of action should be reflected in the design of the demonstration but it must be remembered that some part—perhaps the major part—of the dispute is over values possessed by various parties in a decision, and value conflict will not be resolved by a demonstration project.

Even in cases where there are important disputes over potentially knowable facts such as the level of pollution or costs associated with a particular production process, groups that expect ultimately to oppose the adoption of an innovation (whatever its outcome) may oppose the conduct of a policy-formulating demonstration. Such demonstrations are frequently seen as a means by which a Government agency or industrial corporation that has already made its decision initiates action. These groups tend to doubt the Government's assurance that a demonstration is focused primarily on obtaining information about the desirability of pursuing a course of action. This problem is heightened by the nature of Government-industry relationships that seem likely to lead to successful commercialization efforts—i.e., close and sympathetic ties that promote a good exchange of reliable information.

If the two propositions advanced here are correct, Congress has important contributions to make to the conduct of many policy-formulating demonstrations. Where legislative action is expected to follow a demonstration, Congress needs to assure that the design of the demonstration is relevant to its deliberations. In particular, it must seek to ascertain that issues in which important political constituencies are likely to disagree are treated in a manner that will help to resolve the debate.

[33]Don E, Kash et al., Our Energy Future, University of Oklahoma Press, Norman, Okla.. 1976, pp. 25-26.

Chapter V

IMPLICATIONS FOR CONGRESS

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In this chapter we review the reasons that the Federal Government may choose to use demonstration projects to promote the use of innovations. These reasons, together with the analysis presented in the previous sections, suggest several implications for Congress. Because demonstrations are not a uniformly attractive policy instrument, we briefly review a number of alternative policies for promoting the use of innovations. We conclude with some questions to be examined in a congressional review of demonstration projects.

Reasons for Use of Demonstrations Projects

The most important implication of the previous chapters is that demonstrations, as *a component of the R&D process,* have a relatively narrow scope of usefulness. For ***policy-implementing*** demonstrations, the analysis and evidence suggest that desirable features for success are a reproducible technology and one that is "well in hand, " together with a well-developed institutional environment whose members are involved with the demonstration. Technologies with low reproducibility or fragmented and undeveloped institutional environments of the types associated with many domestic programs seem unpromising areas for the use of demonstrations.

The situation is less clear for ***policy-formulating*** demonstrations because the criteria for success of such demonstrations are less well-defined and the experience, less extensive. They typically are expensive activities relative to the R&D that precedes them. On the other hand, they may be inexpensive relative to the costs (and risks) of a full-scale initiative.

The Demonstration Project as a Political Tool

In contrast to their limited usefulness in the R&D framework, demonstrations are considered by many to be politically attractive. Demonstrations permit modestly priced responses to emerging political problems; they are, in a sense, a means of symbolic action. Demonstration projects can show constituents that Washington is doing something for them. Demonstrations may be a means of delaying policy decisions while additional information—both technical and political—is accumulated. Demonstrations are a convenient point of compromise between those who would do much and those who would do little.

The Absence of Alternatives to Demonstration Projects

Not only are demonstrations politically attractive but in many instances there appear to be few feasible policy alternatives. If Congress presses R&D funding agencies to promote the application of the results of their efforts, and the agencies are restricted to project grants (rather than to changes in tax codes or widespread subsidy programs), demonstration projects, along with information dissemination systems, are about the only tools available. If decisions concerning regulatory policies—say defining an acceptable level of effluents—will not be made in the absence of a specific case that forces such a determination, a demonstration project may be the only way to force the decision. Because the traditional distribution of responsibilities between Federal, State, and local government generally precludes the direct intervention of the Federal Goverment in local affairs, the demonstration project may be the most attractive available tool for trying to persuade the State or local communities of the importance of the national goal. Increases in regulated prices or changes in the tax codes to make private-sector innovation more profitable may be perceived as placing socially unacceptable burdens on groups such as the poor; demonstration projects are a possible substitute. Thus, while the prospects for success with a demonstration project may not be good, the demonstration may be the best policy instrument available; and in some instances, the importance of the problem may dictate its use.

The Demonstration as an Instrument of Transition: Inherent Difficulties

These qualities of demonstrations pose difficulties for Congress as it performs its legislative functions. Moreover, the role of demonstration projects as instruments of transition means that Congress must proceed in the face of poor and probably biased information. Ideas imbedded in the project are moving from R&D to use; technical criteria are being supplanted by institutional criteria of success. Projects are evolving from the small scale typical of a laboratory to full scale in the field. Control is shifting from R&D personnel to operating personnel. In many instances, this transition is associated with a movement from public to private-sector sponsorship and management. Alternatively, the innovation may shift from Federal emphasis and sponsorship to State and local use. Not only is a transition such as this difficult to bring about, but it gives rise to strong advocacy by individuals and groups with a stake in the innovation.

R&D personnel who have developed a new technology often wish to proceed to the next logical step, a demonstration in the field. Industry, particularly that part associated with earlier development work, may seek a subsidy for continuation into the demonstration phase. Final users such as State and local officials may well see the innovation as a means for enlarged political power or career advancement. Because of the transitional nature of the demonstration, however, most actors have only limited perspectives concerning the worth of the innovation.

The developer may not be aware of all the institutional impediments to the application of the innovation. The final users may have insufficient understanding of the nature of the technology and may have a large personal stake in its application. The industrial firm may see the opportunity to obtain a subsidy for an effort that it might otherwise have to fund itself. In any case, Congress or the senior executive branch officials will be faced with conflicting information.

Incentives for Government Agencies to Use Demonstrations

When considering policies to promote the commercialization of new technologies by the private sector, Congress should take particular note of the nature of the incentives that govern the behavior of Federal R&D agencies. These agencies are under continual pressure from the public and Congress to show that their programs have resulted in technologies and knowledge that are being used. One of the most straightforward means of obtaining an example of use is to create a demonstration project. A demonstration project may thus be viewed as a simple means of placating critics rather than as a component of a well-developed strategy to promote the use of the results of an R&D program.

Even in public bureaucracies where there is a thoughtful policy for promoting the use of technology, there are some undesirable incentives. As we have noted, it is the reality of the R&D process that there is both uncertainty concerning the worth of an idea that is being developed and a likely division of opinion about the most likely outcome of its application. This should result in dropping or sharply redirecting a substantial proportion of R&D efforts before they reach fruition. In the private sector, decisions to continue or cease development efforts are disciplined by the realities of the market, which provides a measure of outcome to which all members of the firm must adhere. In general, the structure of a business firm also makes it clear who will be responsible for various levels of decision. If a member of the firm does not agree with the decision that is made, he has little recourse except to leave the firm.

In the bureaucracy of the public sector, the incentives are different. Frequently, the bureaucracy will possess multiple goals. In energy, for example, program goals encompass both the development of a technological base and the commercialization of new technologies. More importantly, decisons concerning projects to be initiated or continued are subject to considerable public scrutiny. Public officials do not have the luxury of simply making a decision because they have the responsibility and authority to make that decision; they also must justify those decisions before a considerable number of outsiders, many of whom have quite different views concerning the prospects for a technology, the goals of a program, or the appropriate policy tools to be used. Employees of the agency or their friends outside the agency can frequently appeal the decisions to higher agency officials or to Congress itself. The debate over the demonstration of the Clinch River breeder reactor shows that even a Cabinet Secretary and the President are unable to make decisions that cannot be overturned.

The incentives of the Government program manager may also be somewhat different from those of his counterpart in the private sector. The latter program manager will frequently report to higher level corporate officers who have had considerable experience with the development of new products and processes. This program manager can easily be rewarded for knowing when to cut off a development as well as for promoting promising ventures because the firm's management appreciates the risks associated with new product development. In contrast, the public official may frequently have to face the scrutiny of an array of elected officials and citizens who do not share his views of the uncertainty and who take the cessation of a project as an indication of failure on the part of the program manager. As a consequence, he may push for a demonstration project despite its low probability of success in promoting the use of an innovation.

These qualities of a Government agency seem likely to inhibit its effective participation in making sound decisions concerning the commercialization of products and processes developed. It will take such bureaucracies a long period of time to make decisions because so many points of view must be considered. Similarly, it will take time to implement decisions when they are controversial because of the several levels at which the decisions can be overturned. It may well be that the necessary absence of profit-oriented goals within public bureaucracies will increase the influence of personal career-oriented incentives of Government officials in the decision process.

Implications for Congress

The narrow scope of usefulness of demonstrations in achieving R&D objectives, the political attractiveness of those demonstrations, the difficulty of achieving the variety of transitions that they seek to make, and the nature of the incentives for Federal R&D agencies suggest four characteristics of programs containing demonstration projects that Congress might encounter.

1. Congress should expect a low rate of success with demonstrations as a means of promoting the use of a technology.

The transition of an innovation from development to use is difficult under any circumstances. It is likely that Federal officials promote technologies having objectives that are not fully shared by either the private sector or by State and local authorities. Demonstrations may frequently not be the policy instrument of first choice but rather the only politically feasible instrument available. Each of these circumstances makes success difficult.

2. Congress should expect that the information it receives concerning the potential of a proposed demonstration will probably be biased and imperfect.

Again, the goals of transition mean that there are few, if any, experts that have appropriate experience or are in institutional settings that do not bias their judgments. Moreover, the fact that demonstrations are frequently the product of a political decision process means that the parties to that process will have different goals for the activity and hence different assessments of likely success.

3. Congress should expect that there will be frequent confusion over the goals of a demonstration project.

The inherent semantic confusion over the term "demonstration" constitutes the first problem. Demonstrations can be used to prove as well as to display a concept. In addition, the perspectives of the actors involved in the demonstration process may be quite different. Some may be certain that the innovation has been proved and seek only to promote its use; some may be dubious and seek to discover its worth; still others may see the demonstration as an easy way to dispose of a political problem and thus will be primarily concerned with satisfying important constituencies.

4. Congress should expect that the evaluation of the success or failure of a demonstration will be difficult and judgmental.

As policies are formulated, a demonstration can provide important but rarely decisive information. Moreover, the distribution of policy-making through time and among different institutions and levels of Government makes tracing the value of the outcome of demonstrations nearly impossible.

While at first glance, evaluation of policy-implementing demonstrations appears to be simple, our analysis suggests that it is not. The possibility of goal conflict between Federal and non-Federal sectors, the strength of a technology, or the quality of an institutional environment all affect the outcome. A particular demonstration project may not have spawned a large group of replications but may have illuminated the institutional problems so that future efforts to promote the use of new technologies will be improved. The project may have brought a policy problem to the attention of local government and resulted in continued attempts at that level to deal with the problem. It may have sustained an R&D capability in one or more private-sector firms that will lead to successful new innovations. It may have forced the resoution of uncertainties over environmental or other regulations that will make subsequent investment planning easier.

In light of these expectations, Congress should consider whether other types of policy or program actions will better serve their ends or will complement and enhance the possibilities of successful demonstration projects.

Alternative Strategies to Promote the Use of R&D

Five suggested strategies for improving the chances of successful demonstration projects are:

- Conduct engineering tests.
- Change market incentives.
- Modify the institutional environment.
- Subsidize local development.
- Utilize existing projects.

The Congress, and the Federal Government in general, can benefit by considering these strategies as either alternatives or complements to demonstration projects.

Conduct Engineering Tests

The evidence suggests that if there is a high degree of uncertainty associated with technology, a policy-implementing demonstration will have a high probability of failing to achieve its objectives. If this is thought to be the case, a large-scale prototype test or test-bed experiment may be needed. It may be less expensive, quicker, and more decisive than a demonstration project that has to deal with the problems of a real-world setting. If a major barrier to commercial use of a new technology is technological uncertainty, the resolution of that uncertainty may be a sufficient means of promoting the use of the technology.

In the development of large-scale technology there frequently is pressure both to advance technology and to demonstrate its usefulness in a single project; this appproach can have unfortunate outcomes. Experience with the development of major weapons systems is instructive, although the problems arising in those systems are not fully analogous to the policy problem discussed here. The military has often attempted to compress development times of weapons systems by initially purchasing a sufficient number of completed weapons systems permitting realistic operational testing. In many cases, the production of these test systems has begun before all the technological uncertainties have been resolved. The result has been increased costs, lengthened time schedules, and eroded levels of performance.

Despite this experience, pressures for early test and demonstration continue. Enthusiastic supporters of a weapons system do not want it to be discarded and thus seek the maximum commitment to the system. The industrial producers want to minimize the risk of cancellation. Most importantly, developers and sponsors of new technologies perpetually seem to underestimate the amount of uncertainty that exists with a new technology. Thus,

- ***The Congress should seek to ensure that it does not add to the incentives for premature demonstration of an undeveloped technology by pressing to turn engineering tests into full-scale demonstrations.***

IR. L. Perry, Reforms in System Acquisition, The RAND Corporation, P-5482, July 1975.

Change Market Incentives

Barriers to increased market penetration of an innovation frequently have little to do with technological, market, and environmental uncertainties. For example, consider the case of synthetic fuel plants. While there are some technical uncertainties and important issues concerning water rights and environmental damage, the major constraints on commercialization are economic. The price of alternative sources of fuels are simply too low and are expected to remain low enough to prevent the private sector from investing in large synthetic fuel plants.[2] In part, the low price reflects a decision to maintain these fuel prices below the long-term replacement costs through regulation in the interests of other policy objectives. Moreover, the market does not take account ef the value of the increment of "national security" associated with substituting domestically produced synthetic fuel for foreign oil. Perhaps, too, the market does not adequately reflect the interests of future generations who will suffer the consequences of depleted natural fuels.

If the Government determines that it is in the national interest to promote the design and construction of synthetic fuel plants, it could change (or eliminate) the regulations on petroleum prices or it could subsidize the output of synthetic fuel plants. Both actions would allow potential producers of synthetic fuels to respond to market-like forces in ways that seem profitable to them. If such changes are made and alternative sources of fuels are still not developed, either the technology is so uneconomical or the environmental and social impacts so unacceptable that the private sector cannot be expected to develop such plants. If it is politically infeasible to change the regulation of prices or to provide a continued subsidy to new sources of fuel, partial sharing of the cost of an initial "demonstration" plant may be deemed an appropriate form of subsidy. In a sense, the use of a demonstration is a "second-best" solution to commercialization. One should note, however, that in this instance it is unlikely that the demonstration will lead to diffusion of the technology. The fundamental reason for the lack of commercialization has little to do with the absence of the type of knowledge produced by the demonstration. Moreover, if the subsidy were high, that is, if the Government paid a substantial and possibly open-ended share of the cost, many of the valuable indicators of economic viability would be lost. In sum,

- ***When a demonstration is proposed to overcome Government-created market imperfections, serious consideration should be given to altering those imperfections as an alternative to large-scale involvement in demonstration projects.***

Modify the Institutional Environment

The analysis in chapter IV suggested that demonstration programs were not likely to be successful in promoting the diffusion of technologies when the institutional environment is poorly developed. As either an alternative or complement to demonstration projects, the Government may wish to alter the institutional environment.

Earlier we noted that the Department of Agriculture has sought to develop a strong institutional environment as a means of improving the productivity of agriculture through R&D. It was able to do this in part because of the overwhelming importance of agricultural production in the last century. The resulting system has been the product of more than a century of development, has many critics as well as admirers, but has provided a framework within which strong technologies could develop and diffuse.

It is difficult to imagine that the Nation would want to create for other sectors a system as elaborate as that serving agriculture. Less extensive changes can be made, however. For example, the current efforts to promote nationwide performance standards for construction can be seen as a means of simplifying and strengthening the institutional environment. Funding for improved planning, analysis, and research capabilities in local governmental units may be an effective means of improving their capabilities to assess and utilize new technology. Standards developed by the National Bureau of Standards may help the market perform more satisfactorily. Assistance to new industries, either through tax incentives or through specialized technical assistance, may strengthen the institutional environment. On occasion, the Federal Government can promote

[2] Edward W. Merrow, Constraints on the Commercialization OJ Oil Shale, The RAND Corporation, forthcoming.

improvements by bringing elements of State governments together to seek common perceptions of social problems and solutions. Federal authorities can also foster the development of new curriculum and support the training of personnel in the skills necessary to improve the innovative capabilities of the State and local government.

As with any policy, such attempts to improve the institutional environment should be preceded by efforts to determine the real nature of the problem. For example, it has been argued that local schools lack the capacity for useful problem solving. Consequently, proposals have been made for educational extension agents, teacher centers, technical assistance agencies, and other forms of assistance. It is quite possible, however, that the real reasons for the lack of desired improvements stem from the incentive structures that face teachers and administrators at the local level, from the type of training that is provided in teacher's colleges, or from the pressures that changing societal norms are imposing upon the schools. Developing better problem-solving skills may accomplish little. In the absence of good problem diagnosis, attempts to improve the institutional environment may simply lead to additional expensive complexity in the environment. To paraphrase,

- ***Congress should regard policies that seek to develop institutional environments as complements to R&D policies.***

Subsidize Local Development

When a technology of low reproducibility or a poorly developed institutional environment is coupled with a demonstration, Congress may want to subsidize local development efforts to focus attention on a problem of national concern. Such subsidies permit local units of government to implement the forms of new technologies that they want and to modify them in ways that seem appropriate to their particular situations.

There is a growing literature on these types of programs. ' In general, it has been found that a disappointingly small number of programs survive the withdrawal of the Federal subsidy. Par-t of this low-survival rate reflects the opportunistic behavior that characterizes some local government and educational institutions. Also, the bureaucratic needs of local governments may not be served by many of the developments that are attempted. Innovation is never easy, There is a wide range of plausible explanations for the low rate of incorporation of results, and it would be premature to suggest that the observed rate of incorporation is the best that can be obtained. Thus,

- **The *Congress* should seek the *type of experimentation and evaluation that will cast light on the best means to provide subsidies for local development and to incorporate the findings in new or revised legislation.***

Utilize Existing Projects

For some social policies, existing projects or programs may provide information that can only be marginally improved by introducing a new policy-formulating demonstration. In the congressionally mandated program examining means to provide incentives for efficient delivery of health care, such an approach was taken. Health care reimbursement systems already under development or in use by several States were evaluated to provide information about the potential effects of several different approaches to the problem.

There are many advantages to using existing projects. Since they already exist, information can be more quickly obtained than would be the case with a new project. Many of the costs of starting a project will already have been incurred. It is possible that the information on implementation problems will be more reliable than would be the case with a federally funded demonstration. On the other hand, the existing project may inadequately reflect important policy options; the project managers may resist being evaluated by Federal agencies; or the project may be structured in ways that make determination of outcomes difficult or impossible. The last case would occur if several policies had been simultaneously implemented in a way that prevented the separation of outcomes attributable to each policy. To summarize,

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'See, for example, Robert K. Yin, Karen A. Heald and Mary E. Vogel, Tinkering with *the System*, Lexington Books, Lexington, Mass., Chapter 5, 1977; and Paul Berman and Milbrey Wallin McLaughlin, Federal *Programs Supporting Education Change,* Vols. I-IV, The RAND Corporation, R-1589 1-4-HEW, April 1975.

- ***In contemplating possible policy-formulating* demonstrations, *the executive branch and Congress should first consider existing sources of insight concerning the policy.***

Suggested Questions To Be Examined in Congressional Review of Demonstration Projects

In cases where these suggested strategies are either undesirable or infeasible or where demonstration projects seem to be the most attractive means for achieving a policy goal, the analysis presented in this report indicates a number of questions that Congress should bear in mind as it performs its legislative functions:

- Are the goals for a demonstration project clearly articulated and agreed upon?
- Given the purposes of a demonstration project, have the information needs of the demonstration's audience been adequately considered?
- If the demonstration is intended to promote the diffusion of an innovation, have the relevant parts of the institutional environment been involved?
- Is the technology underlying the innovation adequately developed?
- Is there sufficient evidence of commitment to the demonstration by the performer?
- Does the design of the demonstration project reflect the experiences of past demonstrations?

Each of these questions is discussed in the following pages.

• Are the goals for a demonstration project clearly articulated and agreed upon?

In some instances, demonstration projects fail simply because of conflicting goals among funders, performers, and potential audiences. As noted, divergence in opinions concerning goals for demonstrations are inevitable given the project's policy role. Inadvertent lack of clarity in goals should be avoided, however. When authorizing demonstration projects or programs, Congress should clearly state its intent. When overseeing the conduct of programs under these authorizations, Congress should seek to ensure that program managers and the performers of demonstrations share an understanding of the purposes of demonstrations.

• Given the purposes of a demonstration project, have the information needs of the demonstration's audience been adequately considered?

Demonstrations, whether conducted to inform Federal policy or to promote the use of an innovation, should be focused on the information needs of its particular audience. A careful analysis of their needs should precede the initiation of a demonstration. It is important to decide what information a demonstration must provide and how it will be conveyed. It is equally important to decide what information a demonstration cannot generate and make that clear to the intended audience. The Congress should seek to ensure that this has been done.

• If the demonstration is intended to promote the diffusion of an innovation, have the relevant parts of the institutional environment been involved?

Evidence and common sense suggest that the institutions important to the success of the demonstration should be involved in its planning and conduct. This includes, for example, those who must change the existing regulations to permit the use of an innovation, the industrial firms that will supply the innovation, and the professional groups that will sanction its use.

Involvement does not necessarily mean participation. It is clear it would be difficult and time-consuming to arrange the participation of all relevant elements of an institutional environment in decisions concerning the design of a demonstration project. Involvement may include, for example, consultation, specialized dissemination of results, participation in evaluating projects, as well as participation in the demonstration project itself. Congress should ascertain that adequate attention has been given to this involvement.

• Is the technology underlying the innovation adequately developed?

Evidence in the literature suggests that when substantial technological uncertainty surrounds a proposed innovation, the purposes of the demonstration can be compromised. Costs will escalate. Potential users of the innovation may perceive it as unreliable. Compromises in the conduct of the demonstration will then have to be made to accommodate resolution of the technical problems. Congress should seek to ensure that the technology associated with the demonstration is sufficiently well in hand to preclude technological problems from dominating the outcome of the demonstrations.

- Is there sufficient evidence of commitment to the demonstration by the performer?

The difficulties and the complex array of incentives associated with any demonstration project make commitment on the part of the participants an important factor in its success. In the private sector, the best indicator of such commitment is the willingness to assume a substantial share of the costs of the demonstration. Experience also suggests that projects that are conceived by the private or State and local sectors themselves are more likely to have this commitment than projects developed in response to detailed solicitation by Federal agencies.

In a few cases, this type of indicator maybe inappropriate. A willingness to invest funds implies a belief that the conduct of the demonstration is clearly consistent with the goals of a firm or organization. For some innovations, however, there will be Federal interest in promoting goals that are not currently consistent with those of private firms or public agencies. For example, the use of cable television to deliver social services to the aged and the poor may require changes in the behaviors of social service agencies and costs to cable television franchises that are unlikely to be recovered through fees. It may be impossible to implement an innovation like this in the absence of almost total support from the Federal Government. Demonstrations of programs dealing with a new and difficult clientele face similar problems. Much of the Federal involvement in elementary and secondary education was brought about by the failure of the Nation's school systems to deal adequately with the needs of disadvantaged students. Given that these schools did not consider this problem to be important, it is unlikely that they would have been willing to make a substantial financial commitment to demonstration projects dealing with the problems of the disadvantaged.

In general, however, Congress should abandon cost sharing as a measure of commitment only if the goals of the demonstration are of significant national importance, and if the potential gains from the demonstration outweigh the higher probability of its failure when the performers are unwilling to make financial commitments.

- Does the design of the demonstration project reflect the experiences of past demonstrations?

The failure of a demonstration project to contribute to formulating a policy or promoting the use of an innovation is not necessarily an indication of wasted public funds. As we have repeatedly noted, the task that a demonstration project seeks to perform is difficult. Apparent project failures may well reflect problems with the institutional environment, conflicting goals at differing levels of government, or other factors discussed in this report rather than poor management or inadequate funding.

These failures are likely to contain important lessons and may point the way to better future policy and program design. For example, while the ambitious demonstration of educational television has left comparatively little in the way of significantly changed patterns of instruction, it has heightened our knowledge concerning the process for changing these instructional patterns. Cable television demonstrations and experiments have clarified the conflict between the incentives driving the expansion of commercial markets for cable systems and the desire to use such systems to enhance the access to services by disadvantaged groups in society. Demonstrations of solar heating and cooling have served to highlight aspects of the institutional environment to be developed.

The lessons learned from these demonstrations can lead to policies to encourage the development of the institutional environment. They can provide guidance for future technological developments. Congress should promote efforts to learn these lessons, and, where appropriate, encourage new demonstrations that reflect them.

The Future Use of Demonstration Projects

Demonstrations constitute fascinating policy tools. They provide opportunities to try innovations; they can be used to promote important causes; they are exciting experiences, for both sponsors and performers. But demonstrations are also easily misused. They can lead to waste, frustration, and discouragement. We hope that the concepts and guidelines developed in this report will help Congress and others to improve the use of demonstrations in pursuing national goals.

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