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DIFFUSION AND UTILIZATION OF SCIENTIFIC AND TECHNOLOGICAL KNOWLEDGE WITHIN STATE AND LOCAL GOVERNMENTS

Irwin Feller
with
Patricia E. Flanary

University Park, Pennsylvania 16802

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Irwin Feller
Director
Institute for Policy Research and Evaluation
and
Professor of Economics
The Pennsylvania State University

with

Patricia E Flanary
Research Assistant
Institute for Policy Research and Evaluation
The Pennsylvania State University

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Section I

Diffusion and Utilization of Scientific and Technological Knowledge Within State and Local Governments

Introduction

This report describes the state-of-the-art concerning current knowledge of the processes by which technological innovations and scientific information are disseminated and diffused among state and local governments and the effectiveness of various mechanisms, strategies and approaches by which federal agencies, either directly or through the support of intermediary organizations, have sought to transfer technological innovations and scientific and technological (S&T) information to branches of state, regional, and city governments. The assessment is based upon a comparison between the theories and institutional arrangements subsumed beneath existing transfer mechanisms and the findings from recently conducted research on the processes and institutional characteristics which condition the acceptance and implementation by state and local governments of externally generated technologies or information. The assessment also draws upon formal evaluations of specific technology transfer projects, although, as described in detail in the following sections, little of the current activity in the fields of technology transfer or information dissemination to state and local government has been subject to formal evaluations, and, indeed, there are major questions as to the appropriate forms such evaluations might take.

In this report, federal agencies are treated as a group except for references to the specific programs of given agencies. A companion report will address the specific issues of the role of NASA and of other federal agencies in the transfer of technology and technical assistance to state and local governments.

The single most important criteria employed in this report for arriving at conclusions concerning the effectiveness of alternative transfer strategies are (a) the compatibility of these strategies with the decision-making environment(s) of the potential users and (b) the likelihood that these strategies will generate changes in such a manner that the changes remain after the prod of external stimuli are removed. Thus, the concept of "success" or effectiveness as applied to an approach in this report relates to the generation of sustainable change. This criterion can be different from that more generally used to gauge the success of a federal technology transfer program. For example, as detailed below, the criterion employed here for judging whether or not a technology transfer program is a success is that an innovation be used and incorporated into an organization's operating practices. Thus, "success" tends to be based upon "user" standards. This is a different standard than measuring either the number of organizations who have received information about the innovation or even who have adopted the innovation. These measures are "supplier" oriented

Some background on the perspective and the approach taken in this report is in order. The search for a better general understanding of the processes by which scientific and technical information are transferred to state and local governments and a specific assessment of the

efforts of the federal government to foster this transfer reflects a combination of perceptions and conclusions: first, that state and local governments have yet to fully capitalize on the efficiency and quality gains in service delivery that are possible through an increased use of scientific and technological knowledge, and second, that public benefit from publicly funded research and development could be increased if there was a more extensive transfer of the "outputs" from this federal investment to state and local governments.

One of the more influential statements of this theme appears in the 1972 Report of the Committee on Intergovernmental Science Relations to the Federal Council for Science and Technology, Public Technology: A Tool for Solving National Problems.

> The current shifting of national priorities is leading to major shifts in Federal programs to meet domestic needs... Unlike the massive effort to develop our military and aerospace capabilities, however, this newer application of science and technology is being applied directly to problems which are basically the responsibility of State and local governments. If the Federal investigation of such problems as pollution, rural poverty, traffic jams, housing shortages and urban congestion is to be useful, the ability of State and local governments to apply new solutions involving science and technology is of critical importance. The main thesis of this report is that State and Local governments, to a large extent, are not prepared to handle this public technology role, and that the Federal government is doing far too little to involve those units of government in the formulation of science and technology priorities addressed to domestic needs.[1]

One of the most significant recent changes in emphasis in technology transfer/information dissemination programs has been the recognition by federal agencies that state and local governments are not solely passive respondents to changes initiated by the federal government but rather are independent, autonomous, and indeed, even

increasingly assertive, actors. The reasons for this shift are many--understanding, sensitivity, experience, response to presidential messages concerning intergovernmental partnership, etc. Indeed, one could legitimately question whether these changes are substantive alterations or largely bureaucratic maneuvers by federal agencies to nominally meet another external challenge to existing procedures. Regardless, however, of motivating influences, the more important point is that the research and development and technology transfer/information dissemination programs of federal agencies now do provide for formal involvement of the state and local user communities

Much of the debate of the past decade concerning technology transfer has revolved about questions of technology-push and need-pull, and the relative emphases to be given to each approach. In general, technology transfer programs have derived from what Havelock has termed the R&D process model. The model entails an ordered sequence of steps from research to development (including the preparation of prototypes) to the point at which the innovation " . is ready to be mass produced and diffused to all members of society for whom it might be useful " As Havelock notes, this orientation is contained in the statement that "if the knowledge is there, a user will be found for it." In more general parlance, the view has come to be known as the "technology-push mode." An alternative approach cited in the Havelock schema, is that of the "problem-solver." Here, "...the need of the client, whether stated, implied, or assured, is only one place to start an analysis of knowledge utilization." More importantly, this approach stresses the need for outside change agents or problem solvers to "...act in a two-way reciprocal and collaborative manner..."

with the client.[2] While these two "ideal types" are important concepts, containing not only different perspectives on the processes of change but also organizational and programmatic implications, they do not carry one far in understanding how the need-pull process operates or how a federal agency can most effectively relate to this pull impetus. The distinction between technology-push and need-pull approaches is more useful today in summarizing modes of thought than as a formal dichotomy. Sufficient experience has been garnered over the past two decades and enough written about the limitations of reliance on the "build-a-better-mousetrap-and-push-it approach" to technology transfer to make repeated criticism of that approach alone somewhat of a strawman.[3] Lambright and Teich's assessment of the elements of an effective technology transfer program is of particular relevance here, since it is based heavily on the experiences of federal laboratories:

> Establishing a delivery system requires overcoming the fragmentation of institutional actors performing the various functions required in transfer. The actors must be linked with one another in different ways at various times during the transfer process A dynamic equilibrium must be established The equilibrium consists of a balance between the "push" from the technology promoter and the "pull" from the user. It is dynamic because it must change and move as transfer proceeds [4]

Federal policies to promote the transfer of technology to state and local governments are now in their second generation rhetoric. The limitations of the "technology-push" mode are by now becoming apparent; the dominant theme today is that of "user needs" or "user orientation." Such an approach sets forth certain simple but nevertheless important themes. From the standpoint of the user, the end

result of technology transfer is adoption and implementation by his organization. A principal shortcoming of the technology-push mode was that the technologies being offered did not address the problems deemed most important by the operating agencies. When matched against key decision variables, such as cost, technical reliability and availability of support systems, proffered technologies were not suitable for the state and local agencies for which they were nominally designed

The logic of the user-need approach is buttressed by evidence on both the characteristics of successful innovations in the private sector and on the factors which influence state and local agencies to accept or reject new techniques.[5] However, the conversion of logic and empirical findings into workable federal policies is far more difficult. User-orientation has become a buzz word in the rhetoric of intergovernmental science relationships. Increasingly, federal technology transfer and information dissemination programs have incorporated user-need components. However, little is known about the effectiveness of these programs, in part because of the absence of systematic evaluation of the major programs along these lines and in part because of the recentness of many of these efforts.

Organization of Report

The report is organized as follows Section II contains a discussion of the multiple policy objectives being pursued under the general heading of "technology transfer." The purpose of this section is to make explicit the analytical and empirical basis for public sector

technology transfer/information dissemination programs, to note the presence of multiple objectives, and to outline the issues related in determining appropriate or best approaches when single programs are undertaken for divergent objectives. Section II contains a discussion of the general characteristics of "various mechanisms, strategies, and approaches through which attempts have been made up to now to provide the technological assistance needed by local and state jurisdictions."[6]

There are many ways in which the complex set of issues, projects, and proposals related to these policy objectives can be organized. This technology transfer literature alone is quite voluminous, and, indeed, there are already several studies specifically related to the technology transfer programs of NASA.[7] The approach taken in this report is thus not to restate the general issues raised throughout this literature but to highlight specific factors which are held to affect the reactions of state and local governments to externally generated technologies and scientific and technical advice. These reactions entail far more than the evaluation of performance characteristics of a technology or the oft-cited barriers of inadequate funds or absence of trained personnel They extend to relationships between and among levels of government, the locus of decision making within each level, budgetary practices, career patterns for change agents, and organizational characteristics, "styles" of change, and the degree of interrelationship between "technical" and political" aspects of the decisions made by political organizations.

These influences are described in Section IV through VI. Each of these sections begins with a general statement of trends at the level of government being analyzed, followed by an examination of the

suitability of different approaches in light of these trends. The discussion of the appropriateness of alternative approaches is based on a review of the findings of specific projects which embody these approaches. The organizing units for the analysis of the state-of-the-art for each level of government are alternative approaches, with specific projects serving as data points. The report thus provides a "user"-shaped critique of existing federal technology transfer and S&T dissemination programs and activities. This role of project-specific information should be noted The report was not intended to provide a summary of mechanisms..., etc. It was not intended as a descriptive summary of the array of federal programs or projects which have technical assistance characteristics. The conclusions of the report are summarized in Section VII.

Data Base and Assessment Criteria

Descriptive as well as analytical treatments of several of the topics treated in this report have recently been published. Duga,[8] for example, has surveyed the status of state science advisory bodies, Gordon[9] has categorized federal technology transfer programs; Roessner[10] has analyzed the characteristics of federal technology transfer programs, Baer et al. have evaluated the effectiveness of federal demonstration projects.[11]

The project descriptions presented in Sections IV-VI derive heavily from reports submitted by investigators to various federal

agencies. Use of this "data" base raises six major questions concerning the formal characteristics of the evidence contained in the reports and thus the "firmness" of the final state-of-the-art assessment in each section. First, a substantial number of the reports lack any semblance of a formal evaluation component. Project objectives are often numerous and are frequently amorphous Little documentation is provided on the gains achieved through the project or on the extent to which observed changes can be attributed solely to the strategy being followed. Second, there remain major conceptual problems in attempting to identify, much less measure, many of the changes sought in technology transfer projects, particularly those related to "capacity building," as contrasted, say, with those aimed at fostering use of a specific technological innovation. Third, the claims for effectiveness of specific strategies generally derive from the performers of specific projects and seldom have been subject to third-party reviews and validation. Fourth, several major efforts at fostering the transfer of technology in the public sector, such as the Urban Technology System, are now, at the time of the writing of this report, undergoing formal evaluation, so that any assessments contained in this report must be regarded as tentative. Fifth, the evaluations undertaken to date of technology transfer and S&T information dissemination projects largely appear to reflect the criteria of the federal agencies which have supported the projects and not those of users who might invoke different criteria concerning whether to continue a project after the initiating federal stimulus has been withdrawn. Sixth, the evaluations which have been prepared tend to be summative rather than process-oriented.

Although this report draws upon project documents as well as on other studies, it should be made explicit that a substantial portion of the judgments expressed herein are derived from the principal investigator's personal involvement in activities relating to intergovernmental science policy as a researcher, as a participant in federal, state, and local government conferences and workshops on these topics, as a consultant to various federal and state units, and that these judgments draw upon what can best be termed an "oral tradition," which has only recently begun to appear in print, on why certain approaches seem to work better than others.

Footnotes

[1]Report of the Committee on Intergovernmental Relations to the Federal Council for Science and Technology, Public Technology: A Tool for Solving National Problems (Executive Office of the President, 1972), p. 1.

[2]Ronald Havelock, Planning for Innovation (Ann Arbor, Michigan. Center for Research on Utilization of Scientific Knowledge, 1971), pp. 2-40-42.

[3]National Academy of Engineering, Technology Transfer and Utilization (Washington, D.C.: National Academy of Engineering, 1974)

[4]W. Henry Lambright and Albert Teich, "Technology Transfer as a Problem in Interorganizational Relationships," Administration and Society, 8:1(May 1976) 29-54, 31.

[5]Summer Myers and Donald Marquis, Successful Industrial Innovations (Washington, D C U.S. Government Printing Office, 1969), National Science Foundation, NSF 69-17, Irwin Feller and Donald Menzel, Diffusion of Innovations in Municipal Governments (University Park, Pa Center for the Study of Science Policy, 1978); Robert Yin, Karen Heald, and Mary Vogel, Tinkering with the System (Lexington, Mass.: D. C. Heath and Company, 1977), W. Henry Lambright, Albert Teich, and James Carroll, Adoption and Utilization of Urban Technology A Decision-Making Study (Syracuse, N.Y. Syracuse Research Corporation, 1977).

[6]Technology Transfer study, Statement of Work, NASA Contract NAS5-24329.

[7]W. I. Doctors, The NASA Technology Transfer Program. An Evaluation of the Dissemination System (New York, N.Y · Praeger Publishers, 1974).

[8]Jules Duga, Science and Technology in State Government Policy-making Past, Present and Potentials, Report to the National Science Foundation, Grant No. GT-44225.

[9]Benjamin Gordon, A Study to Review and Analyze Federal Effects to Transfer Technology to State and Local Governments (Bartelle Columbus Laboratories, 1977), Report to the National Science Foundation under Grant No. PRA 76-21057.

[10]J. David Roessner, "Federal Policy and the Application of Technology to State and Local Government Problems," Policy Analysis (forthcoming).

[11]Walter Baer, Leland Johnson, and Edward Merrow, Analysis of Federally funded Demonstration Projects: Final Report, R-1926-DOC (Santa Monica, Calif.. RAND, 1976).

Section II

Policy Objectives Reviewed

Concern with the use of new technologies by state and local governments and with their access to scientific and technology information derives from three basic sources which are labeled here. the "public technology" view, the "technology transfer" view, and the "S&T capacity building" view. The key distinction made in this report between capacity building, technology transfer and public technology is that the intent of the first is to upgrade the internal decision-making capabilities of the users, while the latter two focus primarily on disseminating S&T knowledge from the federal agency.

The "public technology" view is that the institutional characteristics and structure of incentives in state and local governments constitute barriers to the adoption of new technologies. Furthermore, confronted by these barriers, private industry is held to lack an adequate economic incentive to attempt to develop or to market new products destined for the public sector. The combination of a general aversion to new technologies and a slow response to those technologies which are accepted means that state and local governments operate with outdated and inefficient technologies. This resistance to new technologies is thought to be one of the causes of the low levels of productivity generally found in public sector operations.

The "technology transfer" view is that the national investment in research and development will be increased by encouraging additional uses of the knowledge gained through federal R&D activities, and that

specific domestic objectives (energy, health, housing, transportation) can more readily be attained if there is a systematic application of new technology to these fields. In this study, technology transfer represents the efforts by a federal agency to promote the use of technologies developed under its sponsorship by users other than itself. For this study, the relevant other users are state and local governments.

The case for federal technology transfer or technology sharing programs has been frequently stated in Presidential and Congressional documents. Thus, President Carter's memorandum of February 25, 1977, to Heads of Executive Departments and Agencies noted that "...state and local involvement is critical to the ultimate success of this Administration because:

> State and local sectors constitute the delivery mechanisms for most of the actual services the federal government provides,
>
> State and local concerns, as well as their expertise, should be considered as programs are being developed in order to ensure the practicality and effectiveness of the programs;
>
> Such early participation by state and local officials in our planning process will help ensure broad-based support for the proposals that are eventually developed,
>
> It will ensure that priorities developed at the federal level will work in conjunction with, and not at cross purposes to, priorities at the state and local level.

The objectives of public technology and technology transfer programs overlap. However, not only are they not identical, but, indeed, they may even be antithetical to one another. Moreover, different approaches and/or different combinations of approaches, such as project or capacity-building grants, appear to have a greater chance of producing a successful outcome if they are directed solely at one of the

objectives. Without clearly delineated objectives, there is a risk that approaches may be misapplied.

The questions of the processes by which new technologies were introduced into the operations of state and local governments and the processes by which these levels of governments searched for and utilized scientific and technological information became "issues," and thus the subject for public concern and public programs in the 1960s. Exploration of the general nature of these concerns is a necessary introduction to subsequent sections, especially those which relate to the description and assessment of the effectiveness of federal programs, because for the most part current and proposed public programs reflect an assessment that prevailing and/or traditional processes are inadequate. For example, the development by industry of new technologies for use by state and local governments and subsequent changes in the methods by which these users deliver public services have unquestionably occurred over time. The issue of "public technology" arises only when attention is drawn to the "hesitation" of private industry to invest in research and development activities directed at state and local governments and/or the resistance of these governments to new technologies and practices. Similarly, the advent of new problems requiring new types of information for decision making is not a recent phenomenon of either the executive or legislative branch of state or local government. What is new, however, are concerns that the rate at which such new problems are arising has increased; that the consequences of "unsound" policies, including failure to consider long-term or external impacts of policies are greater; and that the gap between that information which is available and that which is required for sound policies has widened.

This syndrome is perhaps best summarized in the moon-ghetto metaphor of the mid-1960s, namely that if America has the resources, technological knowledge, and managerial skills to place a man on the moon, it must also have the requisite skills to solve problems of the cities, of health, of education, ...and so on.[1] This outlook was reflected not only in the rhetoric of public policy--the "war on poverty"--but in efforts to organize and manage public problems in certain target areas, e.g., cancer research.

The concerns underlying both the use of new technologies and of scientific and technological information have been widely stated.[2] They represent a mixture of theory, data, and prediction. The validity of each of these components has itself become a subject of debate. The following sections are intended to provide an overview of the principal points raised in these concerns along with a summary statement of the state-of-the-art concerning research findings which bear upon these points. Again, the emphasis in this report is not on these debates as such but on the role that such positions occupy in both the general justification for federal programs and in the specific strategies chosen.

The general climate for innovation in state and local governments has been characterized as follows

> All in all, our state and local governments are superbly equipped to do tomorrow what they did yesterday. But these governments are not designed to be highly efficient, responsive, flexible, or innovative. Any effort in this direction must run against the momentum of the system. This government structure has little surplus energy to devote to change and innovation... Typically there is little capacity to design new programs, or to put them actually into effect. New programs and ideas move slowly and fitfully in a climate that is essentially hostile and alien to them.[3]

For the most part, evidence on the resistance of state and local governments to new technologies consists of illustrative examples of the nonadoption or slow rate of adoption of specific techniques. Thus, an Urban Institute symposium, published in 1970, entitled, The Struggle to Bring Technology to the Cities, highlighted as symbols of the resistance to new technologies the "continued reliance" of fire departments on cotton hose (in contrast to synthetic hose which has been marketed since the 1950s) and the reliance of traffic departments on fixed-time electromechanical devices in contrast to more recent variable-time mechanisms.[4] Another study of innovation in municipal fire departments conveyed this same image, first by its title "Fighting Fires: Only the Truck is New," and then by the following

> Next time you happen upon the scene of a fire, fight the impulse to watch the flames Instead, watch the fire department. What you will see is 19th-century technology and techniques fighting an age-old menace.[5]

This reported obsolescence in fire fighting technology is seen as only part of a general resistance to new practices.

> The fire department is not the only public service area whose technology is archaic and outmoded Police, traffic control, and sanitation departments also use the same types of tools, now as they did a half-century ago. Yet, this lack of progress cannot in most cases be attributed to an absence of newer technology.[6]

These characteristics of responsiveness of state and local governments has led to an acceptance of the view that there are inadequate economic incentives for private industry to operate in these markets. Little is known, however, about how firms already producing for public

sector agencies determine their research and development and marketing strategies, or what their experience has been. Even less is known about possible variations within broad sectors in these markets, such as those between state government or local governments, or governments within certain size categories, or more narrowly defined functional or product areas, such as that between fire protection and garbage collection, or between fire trucks and breathing apparatus in the first field and between compactor vehicles and incinerators in the second.

For the most part, current knowledge of the operations of the markets for new technologies in state and local governments derives either from accounts of practitioners or from those of disappointed entrants, most notably aerospace firms, in these markets. Most of the analysis tends to emphasize the problems that these latter firms have had in selling new products to state and local governments.[6]

Frohman, based on a study of the fire equipment industry, contended that several of its market structures inhibited the generation of new technologies:

> Fire equipment manufacturers appear on the average to be old, well-established firms heavily concentrated in the Middle Atlantic and Midwestern states. Most are small two-thirds have fewer than 100 employees. The smaller firms tend to remain small, apparently because profits are too thin to generate growth. They lack the resources to sponsor much new product development.
>
> Larger firms that have the resources to develop new products for the fire services appear to find other markets more attractive. Most products used by fire services were initially developed for other marketers. For example, three manufacturers sell to fire fighters breathing equipment originally designed for miners, aviators, and scuba divers.

> Manufacturers in general are not familiar with the needs and operations of fire fighters for several reasons. The distributors serve as a buffer between manufacturer and customer. While the distributor reduces the number of contacts a manufacturer needs to sell nationally he tends to insulate the manufacturers from reports about this product from customers.[7]

Interviews conducted by Feller as part of an ongoing study into the strategies that manufacturers employ to market new products in local governments support several of these observations. They also, however, indicate a more complex and varied pattern of manufacturers' interest in, knowledge of and assessment of new product development for state and local governments.[8] The market for certain lines of fire equipment, for example, was found to correspond to Frohman's description. Thus one leading manufacturer of fire trucks described his company's attitude as not one of selling but rather that of taking orders. On the other hand, manufacturers of other product lines, such as portable infrared heat detectors, have sophisticated product development, field testing, and marketing strategies. Manufacturers who do sell through distributors appear to have done so in part to insulate themselves from the vagaries and annoyances of the municipal market, such as slow payment practices, and thus, as noted above, they appear to have placed themselves in a position where they are often attempting to promote a technology (e.g., breathing apparatus) which was originally designed for other markets. Other manufacturers sell through their own representatives. In such cases, even though a specific product may be used by both industrial and government customers, the manufacturer appears to be not only well informed of the specific needs of state and local governments, but has taken these needs into account in

the design or pricing of the product. Moreover, while there clearly do appear to be higher costs in certain aspects of selling to the state and local governments (more frequent visits in order to meet with the larger number of officials likely to be involved in the purchase decision or slower payment practices on the part of government), these costs can be offset in several ways (e.g., higher product prices, larger orders).

The state-of-the-art concerning the general background of the characteristics relating to the supply of and demand for new technologies in local government is most succinctly presented in Table II-1, which derives from Roessner's work.

Roessner's classifications are based upon a synthesis of empirical data concerning municipal expenditures in the four functional areas, case studies of innovation in the selected areas, and a review of the recent literature on adoption and implementation of new technologies within public organizations. His conclusions are of particular interest in this report because they relate directly both to the issue of the selection of alternative objectives and to the choice of appropriate strategies which federal agencies can pursue to achieve those objectives.

> ...the Federal Government has an array of policy mechanisms available to influence the rate of technological change in municipal service delivery. The data presented here suggest that intervention strategies will literally have to be tailored to each functional area of concern and, in some cases such as mass transit, to the product line itself.
>
> In my view, the most promising leverage point for federal policy intended to increase technological change in municipal services concerns local government's ability to identify problems systematically and define them in technical terms, to search for alternative solutions that include but are not restricted to innovative ones, and to evaluate the alternatives. Federal

TABLE II-1

SUMMARY OF SUPPLY AND DEMAND CHARACTERISTICS OF LOCAL GOVERNMENT MARKET FOR TECHNOLOGICAL INNOVATIONS

	Market Size	Market Description	Industry Structure	Industry Financial Condition	Industry Investment In R&D	Federal Funding In Functional Area	Federal R&D	Federal R&D For Equipment	Federal Regulation Affecting Equipment Purchases	Federal Role In Standards and Information
Fire Services	$100M Capital Outlays, 1975-76	highly fragmented due to procurement practices, traditional, low technical capabilities in fire departments	several hundred firms, few large firms	small firms financially	very low	NFPCA $12M FY 1977 new agency	NFPCA $2M FY 1977	<$2M	slight	small but increasing, NBS, NFPCA training and info dissem. increasing
Law Enforcement	$180M Capital Outlays, 1975-76	fragmented, little cooperative purchasing	over 700 firms few market exclusively to law enforcement, small firms dependent on distributor network, competitive	low profit margins for firms dependent on law enforcement market, supplier firms generally perceive low profit margins	little done for law enforcement market; "spinoff" from other market R&D	LEAA $650M FY 1977 heavy support to states since 1970	NILECJ $44M FY 1977	NILECJ $3 4M FY 1977	states allocate federal funds	LESL active since 1971, considerable training and dissemination efforts
Mass Transit	$1B annually Capital Outlays 1970-1980 Buses 5000 annually Railcars 400 annually	Buses little standardization, market size varies widely over time, uncertain, "lumpy" Railcars highly uncertain, lumpy, conservative practices of engin's consults, lack of standardization, risk averse envir	Buses near monopoly recently changed to oligopoly innovation occurs with component suppliers Railcars not clearly defined, substantial foreign competition	Buses evidence of profitability Railcars several firms experienced large losses, several have left the market entirely	difficult to estimate	UMTA roughly $1B annually, $9B spent since 1965, construction and capital improvement	UMTA RD&D $59M FY 1977	UMTA $30M for Transbus	substantial, low bid requirement; labor protection clauses, escalator clauses permitted only recently performance requirements	Buses Transbus program would have introduced standards Railcars slight
Waste Water Treatment	$400M for equipment, 1977	highly risk-averse envir due to large-long-term investment, influence of consulting engineers, nature of municipal decision process (complex long)	about 300 firms competitive	relatively low profit margins compared with manufacturing average	small	EPA $5-6B annually for construction	EPA Water Quality $44M	EPA $11 4M 1975	substantial, EPA effluent requirements must be met	

Source: J. David Roessner, "The Local Government Market as a Stimulus to Industrial Innovation," Paper prepared for the Workshop on "Government Demand as an Instrument to Stimulate Innovation in Industry," Dublin, Ireland, June 1978, Table 3

> programs designed about such a focus would probably not be popular with federal agencies, nor would they be easy to define to the Congress. Their benefits would be measured in increased capacity to solve problems, not by number of research reports disseminated or read, number of new pieces of equipment purchased, or number of new procedures tried. Further, the result of a federal agency's efforts to increase the technical competence of its municipal client may be more effective and pointed criticisms of that agency's R&D program.[9]

In summary, the present state of knowledge concerning the practices and experience of private industry in developing and selecting technological innovations for the public sector has advanced to the point where questions and reservations can be raised concerning the contention that there are "pervasive" or "insurmountably" high barriers to such private sector activity, but not much beyond.

Capacity Building

In an intergovernmental context, capacity building refers to those federal policies and programs which are intended to strengthen the capabilities of state and local governments in the range of activities--policy management, program management, resource management--which are required for improved public management. Two principal justifications have been advanced for federal support of this type

> First, increasingly the success of Federal mission objectives will depend upon the skill of State and local governments in carrying out broadly defined federal programs Even in the case of the original general revenue sharing legislation, where the objectives are so broad as to be almost unconfining, there is political pressure to assure that funds are spent as efficiently and effectively as possible.
>
> Second, State and local governments cannot be expected to make sound contributions to the development and implementation of Federal or national objectives until they can manage their local responsibilities. Consequently, the Federal government should be concerned that States and localities are suitably equipped to deal with them.[10]

Although at first reading, capacity building, as presented above, would seem to have little to do with technology transfer or the dissemination of scientific and technological information, in fact, it relates in important ways both to the justification of transfer and utilization programs and to their design. The capacity building approach implies that an objective of federal assistance programs should be a strengthening of the capabilities of state and local governments to make decisions on their own rather than only to adopt or utilize technologies or information developed under federal sponsorship. Under this perspective, an offer of technical assistance by a federal agency to a state or local agency may make the recipient better off in the context of the single problem being addressed, but it will also tend to leave the agency in a state of continued dependency on federal assistance when future problems arise. Alternatively, the federal agency may offer assistance in such a way that the state or local agency becomes increasingly self-sufficient over time. Clearly there is a spectrum between complete dependency and complete self-sufficiency. The objective behind capacity-building programs has not been that each eligible state and local recipient of federal assistance reach the level of proficiency of the federal agency offering the assistance. The objective has been couched in fairly general terms, more to denote a perceived state of being than a measureable set of resources. However, there should not be any question that one of the consequences of a federal program of capacity building is to raise the absolute level of performance of state and local governments and thus over time tend to reduce their dependency upon federal agencies.

The logic of a capacity building approach requires that federal programs be designed to meet the needs and preferences of state and local governments. These jurisdictions, not federal agencies, will thus determine if a specific approach or project fits within its policy-making and decision-making environment. By its very nature, a capacity building program will be more open-ended and flexible than a categorical or competitive assistance program, and even more so than a "demonstration" project. Moreover, since it is the users who will determine what works best, the final products of such a program, given the great diversity in initial capabilities of state and local governments, are likely to be quite diffuse and variegated, thus complicating efforts to assess or evaluate outcomes.

The capacity-building approach is not without its critics, some of whom are drawn from those whose "capacities" are intended to be improved. The basic objections to the capacity-building approach are: (1) that it tends to further attenuate federal-state-local ties in an already loosely coupled intergovernmental system; (2) that inherently it will produce duplicative efforts as jurisdictions are encouraged or underwritten to undertake their own R&D activities; and (3) that it does not provide for standards of accountability and evaluation. These objections are relatively familiar ones at the federal level to block grants in general. The new element in considerations of the capacity-building approach is that there is some evidence, albeit not necessarily representative of all levels of state and local governments or of all geographic regions, that local officials see little use to federal programs defined to upgrade their capabilities, again, at least for certain specific

skills. Thus, Jones and Doss, based on a survey of local government officials in the eight states comprising the southeastern federal region, have noted:

> It must...be remembered that the local governments do not necessarily accept the same goals, much less assign the same priorities to individual goals, as does the national government. It would appear that this assumption is a central flaw in the entire capacity-building concept. No matter how diligently federal bureaucrats try to increase the capability of state and local governments to deal with revenue sharing, block grants, and other new federalism programs, there is a likelihood that many of the so-called benefactors do not necessarily share the enthusiasm for this knowledge. It is possible that most local officials who have had a fair amount of past experience with federal programs believe that they are competent managers, and that they could do an even better job if there were less "red tape."[11]

In this report, we consider two approaches to capacity building. First, many federal agency projects, particularly those funded by the Intergovernmental Programs Office of the National Science Foundation, are intended to test approaches for building the long-term institutional capabilities of state and local governments in the fields of technology transfer and S&T utilization. Thus, many of the projects considered under the sections on state executive, state legislative and local governments represent variations (e.g . internal staff, access to university faculty) of how these governments might develop or draw upon a larger scientific and technological community. Second, a recent block grant, capacity-building program, the State Science Engineering and Technology (SSET) Program, is specifically directed at these issues. The SSET program is analyzed in more detail in Section III.

Intergovernmental Science and Technology Relationships

Although the three categories described above--"public technology," "technology transfer," and "S&T capacity building"--are useful in organizing the array of objectives of technology transfer or information utilization programs, they do not serve to fully identify the range of activities contained within the design of a system of intergovernmental science relationships.

A separate approach used to address the issues in this report is a focus on the activities contained within a single staged approach to research and development. This approach contains the following stages: identification of research priorities (agenda setting), research and development, innovation, and diffusion (transfer, dissemination, and utilization).

From the federal perspective, the main locus of activity typically has been technology transfer. Only when the second and third objectives--public technology and capacity building--are added to that of technology transfer does the complexity of the intergovernmental system become apparent, the need for clarity of objectives more important, and the design of federal programs more fluid. It is in these same areas, i.e., public technology and capacity building, that the federal agencies' understanding of the decision-making processes in state and local governments is relatively weak.

The contrast between the goal of technology transfer and the broader claims of state government for a reorientation of the intergovernmental science system is best summarized in the following

statement prepared by the National Conference of State Legislatures in its assessment of legislative activities under the SSET program. Although couched in terms of state legislatures, this position also expresses prevailing views of representatives of governors' offices.

> ...the role of science and technology in most legislatures is governed by two factors--the actual increase in the number and complexity of S&T issues, and the increased perception of these issues by legislators. S&T in the legislative context centers chiefly around an enhanced capability, not around R&D or technology transfer. The two latter activities generally deal with products or information applied to a specific program or need and may certainly be some of many resources used by a legislative S&T capability; but they are not synonymous with such a capability.[12]

The relationship between the branch of government being considered and its involvement in the various elements in an intergovernmental science system is presented in Table II-2 The scaling from low to high for each activity is judgmental, and is designed primarily to highlight the following points: first, different branches of state and local governments have different stakes (or priorities) in different aspects of the system, second, at the state executive level, a distinction must be drawn between the governor's office and a state's mission agencies. The former tend to focus on science and technology information and advice and thus resemble state legislatures, the latter, which are typically the branch of state government with whom federal agencies have contact are relatively more concerned with technology transfer.

TABLE II-2

Hypothetical Relationship Between Branch of Government and Involvement in Intergovernmental Science

	State Executive		State Legislature	Local
	Governors' Office	Mission Agency		
Scientific Information and Advice	High	High	High	Low
Technology Transfer	Low	High	Low	High
R&D Agenda Setting	Medium	Medium	Medium	Medium

Finally, the notation for R&D agenda setting should be treated with caution. Agenda setting is an activity now in favor at the federal level, as each of the subnational levels of government is being brought into or supported in the conduct of "needs assessment" statements concerning suggested federal R&D priorities. Thus, the Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP), President's Office of Science and Technology, is heavily involved in generating R&D needs statements, likewise, under project grants, are the Urban Consortium, National Conference of State Legislatures (NCSL), and National Governors Association (NGA). How these activities fit within the overall priorities of the users, how influential these compendia will be in redirecting the R&D priorities of federal agencies, or how desirable (or effective) such a redirection would be, if forthcoming, are open questions.

Footnotes

[1]Richard Nelson, "Intellectualizing about the Moon-Ghetto Metaphor: A Study of the Current Malaise of Rational Analysis of Social Problems, Policy Sciences 5(1974), pp. 375-414.

[2]The Urban Institute, The Struggle to Bring Technology to Cities, (Washington, D.C. The Urban Institute, 1971), Bringing Technology to Cities and Local Government, Proceedings of the Wingspread Conference (Washington, D.C.: National Commission of Productivity, 1973); Public Technology: A Tool for Solving National Problems, Report of the Committee on Intergovernmental Science Relations to the Federal Council for Science and Technology (Washington, D.C.: U S. Government Printing Office, 1972), The Council of State Governments, Power to the States Mobilizing Public Technology (Lexington, Kentucky The Council of State Governments, 1972), Frederick Hayes, "Innovation in State and Local Governments," in Centers for Innovation in the Cities and States, edited by Frederick Hayes and John Rasmussen (San Francisco San Francisco Press, 1972), pp. 1-20; Robert Crawford, "The Application of Science and Technology to Local Governments in the United States," Studies in Comparative Local Government 7 (Winter 1973) 1-19

[3]Hayes, op. cit.

[4]Urban Institute, op. cit.

[5]Alan Frohman, "Fighting Fires: Only the Truck is New," Technology Review (May 1973) 36-41, p. 41.

[6]Ibid., p. 41.

[7]Ibid., p. 40.

[8]Irwin Feller, "Municipal Diffusion Patterns," Working Paper (University Park, Pa.: Institute for Policy Research and Evaluation, 1978), NSF Grant No. SOC-7682379.

[9]J. David Roessner, "The Local Government as a Stimulus to Industrial Innovation," Paper prepared for the Workshop on Government Demand as an Instrument to Stimulate Innovation in Industry, Dublin, Ireland (1978).

[10]Strengthening Public Management in the Intergovernmental System, A Report Prepared for Office of Management and Budget by the Study Committee on Policy Management Assistance (Washington, D.C.. U.S. Government Printing Office, 1975): 6-7.

[11]William Jones and Bradley Doss, Jr., "Local Officials' Reaction to Federal 'Capacity-Building,'" Public Administration Review 38 (January/February 1978), 64-71; 71.

[12]John Reuss and Joanna Mack, State Legislatures' Response to the State Science Engineering and Technology Program (Denver, Co.. National Conference of State Legislatures, 1978), Report to the National Science Foundation, Contract C-ISP77-17799, p. 4.

Section III

Delivery Systems

This section outlines various combinations of technology transfer and S&T utilization techniques and channels for delivering S&T knowledge to state and local governments. For the most part, the techniques outlined are elements in any treatment of means by which the federal government provides assistance to other levels of government, and thus only brief descriptions are provided here The substance of the state-of-the-art survey emerges in the articulation of the alternative delivery systems and in an analysis of the issues that emerge in the mesh between techniques and channels.

Various taxonomies have been proposed of the mechanisms or approaches employed to promote the transfer of technology to state and local governments. Gordon, for example, has listed 11 such mechanisms in a recent review of federal technology transfer programs,[1]

1. Technology Agents
2. Direct Application Assistance
3. Back-up Sites
4. Networks
5. Exemplary Projects
6. Demonstration Projects
7. Experimental Projects
8. Clearinghouses
9. Seminars/Training Programs
10. Subsidies
11 Task Forces

In this report, these approaches are collapsed into two broad groups: (1) two general types of funding--block grants and project grants, (2) four specific delivery approaches--field agents, information systems, technology promotion, and need-pull. Allowing for considerable variation in the specific design and implementation of each technique and for numerous possible combinations among them, e.g , networks which combine technology agents, back-up sites, and training programs, these techniques describe the bulk of federal activities in the fields of technology transfer, S&T dissemination and utilization, and intergovernmental science relationships.

Along with these techniques, six channels are considered for the federal delivery of technology and/or scientific and technological advice to state and local governments. One direct channel is that of a federal agency itself or a grouping of federal agencies, such as the Federal Laboratory Consortium for Technology Transfer. A second direct channel is that of the performer itself, that is, a state or local unit conducting an S&T-related activity under a federal grant. The other four channels, universities, professional organizations, networks, and consortia, are classified as third parties or intermediaries in that their involvement in transfer and dissemination activities is underwritten or otherwise induced by federal stimuli. In some cases, e.g., Urban Technology System, the intermediary or network is created specifically to act as a broker between federal agencies and state and local governments. In other cases, however, the provision of federal support is seen as a necessary element in inducing the "suppliers" to add to or to redirect their activities. This approach does not take into account other reasons for relationships between these suppliers

and state and local governments, nor, in some cases, such as university-state government relationships, does it account for more than a fraction of the activities currently undertaken by the institutions. The marginal nature of the federal role in many of these relationships must not be lost sight of. What appears to a federal agency which sponsors a project with an intermediary to be a nationally replicable prototype may to the organization which receives the federal support be a more modest, less universal undertaking, and one which will not be permitted to intrude upon more extensive relationships between it and state and local governments. For example, federal support of a university-based program to augment university assistance to state and local governments may create situations which the university finds disruptive to its larger set of relationships with these levels of government. Thus there may be a disparity between the actual or perceived commitment of a given federal agency to any project or new approach and that shown by any of the intermediaries who may have other previously established relationships with the users or be involved with delivery systems different from those supported by the federal agency

The division between "networks" and "consortia" is made for purposes of analysis only, since in practice many current projects are described one way or the other (e.g., Federal Laboratories Consortium, Pacific Innovations Network) with little attention paid to the consistency of appellations among projects. Indeed, the current popularity of the term "network" may soon lead all multi-organizational projects to be so described. In this report, the term network is used to describe those projects which are based upon relationships among comparable organizations. Thus, the technology agent element within

the Urban Technology System would be described as a "networking" arrangement. Consortia refers to those arrangements which attempt to link different institutions, such as the University of Tennessee project in which the university served, in part, as a broker between municipal governments and industries in that state.

The analytical utility of network/consortia dichotomy is that it highlights two separate aspects of S&T strategies now being tested and formulated. The networking concept is based, in part, on two assumptions: (1) interaction among peers is an important element in the diffusion of knowledge, so that formally linking together various users should accelerate the diffusion process; (2) there are common components in problems faced by similarly situated state and local governments, so that economies of scale can be realized by formulating and disseminating solutions. The consortium approach, in practice, is based on these two assumptions, but also involves a third assumption, namely, that institutional or economic barriers deter sufficient interaction between the suppliers and users of S&T knowledge making necessary the introduction of third-party, brokerage or "linking" organizations.

It is important to consider the channels separately from the techniques. The channels are, to a considerable degree, "substitutes" for one another in the supply of any given technique. Thus, a university institute might serve as the bridge between a state government and the scientific and technological communities, as might, alternatively, a state academy of science or a multi-regional organization specifically created for this purpose. This issue of the relative effectiveness of alternative channels has not generally been raised,

since most of the projects described in this report were initially funded as "experiments" or "demonstrations" and for the most part have continued to operate as such. However, if the federal government (or single federal agencies) decides to maintain or expand programs to foster the spread of S&T knowledge to state and local governments, it seems likely that at some point in the near future consideration will have to be given as to which "experiment" or experiments are to be transformed into established programs.

The issue of state and local officials' access to scientific and technical knowledge has generally been couched in terms of strengthening their ties to the external scientific and technical communities, where these communities have been broadly defined to include universities, federal laboratories, professional scientific and technical associations, and private industry While this general objective is difficult to fault, it does not carry one far in designing programs, in allocating programmatic funds, or in choosing an external supplier or a combination of these suppliers for there is little evidence to indicate pre-existing use patterns of different types of information. There has also been little attention paid to the relative costs or other institutional changes needed to form such ties, or little comparative evaluation of how newly created networking relationships have been employed. Also, the character of existing relationships between state and local governments and these suppliers differs, both generically and in the context of specific settings Relationships between a state agency and a federal agency may be far closer in one state than the relationship between that agency and the state's publicly funded universities, whereas in other

states the opposite relationship may hold. Finally, supplier institutions respond to different incentives, so that there remains the question both of the efficacy and appropriateness of federal efforts to channel or redirect the efforts of these suppliers--whether these be universities or federal laboratories--to problems of state and local concerns.

The matrix of combinations between techniques and channels of assistance is depicted in Table III-1.

TABLE III-1

Delivery Systems for Transferring Scientific and Technological Knowledge to State and Local Governments

	Technique \ Channel			Intermediaries			
		Federal Agency	Performer	University	Professional Organization	Network	Consortium
Funding Mechanism	Block Grant						
	Project						
Delivery Mechanism	S&T Agent						
	Information System						
	Technology Transfer						
	Need-Pull						

Funding Mechanisms

Block Grants

Although most often discussed either in the context of the broad design of financial relationships among federal, state, and local governments or in the context of specific program areas (e.g., education or human resources), block grants can also be considered a technique for promoting the transfer of technology and the accelerated dissemination of scientific and technological information. As such, they are a potential alternative to other programmatic techniques, and indeed have been advanced as such.

Two types of block grants--general revenue sharing and capacity-building grants--are of relevance here. The logic behind a general revenue sharing approach is that the principal limitations on the capability of state and local governments to search for, acquire, and effectively use new technologies or S&T information are that the users lack sufficient funds or adequate access to S&T personnel. Direct provision of additional funds would directly remove the financial barrier to the acquisition of new technologies and permit the employment of technical personnel, if the funds were so allocated. The infusion of new people and practices should then, over time, be expected to awaken state and local governments to the potential of an ongoing access to scientific and technological information and lead them to formulate issues and search for information in a more technologically intensive manner.

There is indeed evidence that the adoption of technology in state and local governments has been accelerated, at least in some

areas, by general revenue sharing. Thus, in the Feller-Menzel study of the adoption of innovations by municipal governments, one manufacturer's representative was quoted as follows

> The general revenue-sharing program of the federal government that began in 1972 has caused a sharp increase in available funds for many fire departments. Anyone who has tried to buy a fire truck lately knows that apparatus delivery lead times have increased tremendously because of it Some departments are using these funds for purchase of fire apparatus and other equipment. ..[2]

In essence, block grants contain a "trickle down" theory of technology transfer and S&T utilization Given some combination of the size of the grant and the priorities of the recipients, a portion of the funds will be used for modernization of operating practices and for hiring new staff. The advantages and disadvantages of this approach in the technology transfer area parallel those for the general arguments concerning the relative effectiveness of block grants, categorical grants, and federal assistance programs--namely economies of scale in the administration of nationally mandated programs, differences in levels of expertise across levels of governments, and the compatibility of "user" preferences with "supplier" estimations of "user" needs. Block grants along these lines represent what might be called the "market" approach to intergovernmental relationship. Under this perspective, money is the limiting factor on the capabilities of state and local governments to perform at the level "expected" or "required" of them by the federal government. Therefore, unilateral, unrestricted transfers of funds from the federal government to the other levels of governments is more consistent with their needs than the establishment

by federal agencies of intergovernmental assistance programs. For if these assistance programs do in fact provide a needed service, the users, now supplied with the requisite financial resources, will be willing to purchase external assistance, and to support federal technology assistance programs through a system of user charges.

The feasibility of this approach has been called into question by those who have examined the institutional settings in which state and local governments define their needs for scientific and technological assistance It has been argued that the political setting of these users which emphasizes immediate service delivery makes it unlikely that block grants will be used to promote the applications of S&T knowledge. Thus, Carey has recently observed.

> A Federal transfer of money is only a part of what is required; the generous transfer of expert personnel, through the Intergovernmental Cooperation Act process could do even more to augment the capacity of the State and local governments for coping. Leveraging the massive Federal R&D expenditure to gain a greater yield to State and local governments is a strategy more likely to pay off than beginning a well-meant but open-ended categorical program to dump R&D dollars on those jurisdictions.[3]

A different type of block grant is represented by the SSET program. The basis of the SSET program is contained in the Congressional Report on H.R. 12566, authorizing FY 1977 appropriations for the National Science Foundation. The report reads as follows:

> ...conferees agreed to express their unanimous conviction... that greater cooperation and improved financial arrangements between States and localities and the National Science Foundation are in order, including additional financial support of programs designed to introduce technology to State and local needs.[4]

Accordingly, Congress approved (but did not appropriate funds for) a $2.5 million program of grants to the states "...to identify and analyze potentially useful ways in which State and local governments can increase their capabilities for using science, engineering and technology in meeting the needs of their citizens, including consideration of the establishment of science and technology policy offices within both the Executive and Legislative Branches." The Conference Report also provided that the study grants were to be submitted to NSF and to the Office of Science and Technology Policy (OSTP) for their respective evaluations. A determination on the scope and size of the SSET was to be made in 1978 based upon these evaluations

Implementation of the SSET program occurred during 1977. Under guidelines prepared by NSF, each of the executive and legislative branches of government in each state was eligible to receive up to $25,000 (with a one-third state match requirement) to conduct a planning program "intended to provide state governments with assistance in the development or improvement of the policy-formulation processes in their states." Forty-nine state executive branches out of 50 applied for funding, as did 42 out of 50 state legislatures.

The Conference Report also provided for an evaluation of the program. The first phase of this evaluation was conducted in mid-1978. This evaluation consisted of three parts: the report of a third-party evaluator (who was selected after a competition based upon a request for proposal); assessments by the National Governors' Association and the National Conference of State Legislatures which had received support contracts from NSF to assist the state executive and legislative

branches respectively in responding to the mandates of the SSET program; NSF's own internal evaluation and the assessment by OSTP.

The importance of SSET is that it represents the first national effort at S&T capacity building within state governments. As such, it represents an important transition from the "project," "demonstration," and "experimental" mode under which most existing capacity building S&T efforts have been funded to a longer-term, general support program through which "capacity" can be built. More importantly, if SSET survives through the executive and legislative budget cycles in the years immediately to come, it will serve to strengthen the ability of state and local governments to shape their own perceptions of their needs for technology and S&T information, to give them an opportunity to develop mechanisms for meeting these needs, and undoubtedly to increase the level of sophistication of how they approach their relationships with federal R&D and technology transfer organizations. The likely result of all these developments is that federal agencies will increasingly find themselves dealing with more knowledgeable, articulate and independent users. A consequence, in turn, would be that federal agencies would have less latitude to select what they alone deemed to be the best technology transfer or S&T utilization strategy, but rather would be increasingly required to make such decisions in consultation with state and local governments. "User" orientation would be less a strategy selected and bestowed by the federal government than an approach demanded by the users as a result of their new capabilities.

Project Grants

Project grants denote the set of activities in which a federal agency funds a nonfederal group to accomplish specific objectives in the area of technology transfer and S&T utilization In one sense, this is a "catch-all" category as it may cover any of many different delivery strategies, may be channeled to any of a set of users or intermediary channels, and may reflect a one-time, ad hoc response to a given situation. It may also be a means by which a federal agency systematically tests alternative approaches before committing itself to a general course of action.

The central appeal of the project approach from the federal perspective is its flexibility, that is, it permits a federal agency to determine the type of activity, level of support, and type of performer, without, in the absence of legislative mandates, making long-term commitments. It can, for example, be used to promote the use of a given technology, say by contracting with professional organizations to run a series of seminars for users; to channel a portion of agency funds along specific lines; to arrange for users to screen an agency's research output with a view towards determining which products developed under an agency's sponsorship have the highest probability for broad-scale transfer; to "demonstrate" the workings of a given technology, with a view towards promoting its widespread adoption, or to "test" the feasibility of new arrangements for linking sources of scientific and technological information such as universities to state and local governments.

The array of activities covered by these approaches is contained in the sections on the users (state executive, state legislative, local) where the compatibility of the specific activities funded through project grants (e.g., demonstrations, seminars) with emerging conclusions concerning the effectiveness of specific activities is considered.

Of interest here are the generic limitations of the project approach towards technology transfer and S&T utilization. The nature of these limitations emerges when one considers the different objectives referred to in the opening sections of this survey To begin with, with the exception of the Intergovernmental Programs Office of the National Science Foundation, where the project approach is used to test methods for strengthening the scientific and technological capabilities of state and local governments, federal agency use of project grants tends to be geared primarily towards the promotion of specific technologies and to a growing, but nevertheless small, degree, to the generation of user input into the determination of agency R&D agendas and the design of information dissemination seminars. Thus, projects seek to "test" or "demonstrate" products rather than processes for linking suppliers and users. Secondly, project-based activities cover a wide variety of approaches and recipients within a given agency, and even more so across agencies While there are some important examples of interagency cooperation in the pooling of project-related funds, e.g., the Model Interstate Science and Technology Information Clearinghouse (MISTIC) project, and in establishing channels for interagency communication, (e.g., Federal Coordinating Council for Science, Engineering, and Technology), generally it appears that there is little

in the way of interagency exchange of the lessons or experiences gained concerning the effectiveness of various programs or little effort made to compare the effectiveness of alternative delivery systems within a given setting.

The long-term impact of project-based activities within the user communities, moreover, remains in doubt. There is an increasing body of evidence which indicates that even when a federal technology transfer or demonstration project is successful in promoting the adoption of a given technique or set of techniques by state and local governments, the viability of the innovations engendered via federal sponsorship becomes questionable once federal funding lapses. Thus, in a nationwide survey of 100 Elementary and Secondary Education Act Title III projects, Berman and McLaughlin estimated that only between 5 and 15 percent of the projects had become fully institutionalized approximately two years after the end of federal funding. They concluded that the overall assessment of the seed money approach to promoting education reform was "mostly" negative. Federal funds have stimulated the local adoption of a wide variety of innovations, but adoption does not assure effective implementation. Nor does effective implementation guarantee the long-run survival of project-related improvements."[5]

This gap between adoption and implementation has emerged strongly in recent studies of the use of new technologies by local governments. These studies share in the conclusion that the adoption of new technologies is often stimulated by external events, including events initiated by federal agencies, such as imposing new regulations or providing categorical grants.[6] The "routinization" of these technologies (that is, the extent to which they become an integral part of the agency's

operations), however, requires that there be a transition to support by local funds, the establishment of stable arrangements for supply and maintenance, the internalization of training programs, the establishment of personnel classifications or certifications, and other comparable transitions. According to a study by Yin et al. of the routinization of new practices in local governments

> The major conditions that lead an innovation to become routinized all appear to be internal to the specific local agency. This is not necessarily an unexpected outcome, but it does suggest that external initiatives (as in a federally initiated agenda) are either limited or will have to be designed with a greater degree of sophistication.[7]

The problem addressed here is best summarized in the title of a June 1978 workshop sponsored by the National Institute of Education and the National Institute of Law Enforcement and Criminal Justice: "The Institutionalization of Federal Programs at the Local Level... What Happens when Federal Funding Runs Out?" The general answer, as indicated by the Berman report and forcibly argued by the participants at this workshop, was that the programs died. Thus, project-based activities may generate change, but the change will be difficult to sustain. Adoption, transfer, and diffusion may occur, but not implementation or institutionalization.

Finally, underlying many project-based activities, both the ones directed at technology transfer and those directed at capacity building, is a theory of diffusion. In this respect, project grants tend to be what has recently been termed "policy-implementing demonstrations,"[8] that is, they are intended to promote the use of an innovation.

The validity and applicability of "diffusion theory" in the design of technology transfer policies is today a topic of debate at every level of analysis--theoretical, empirical, and policy.[9] To provide a separate assessment of the relevance of this debate to the specific topic of technology transfer and S&T utilization in an intergovernmental context would require a separate report In a summary manner, the relevant findings are as follows: There is considerable evidence that state and local governments "cue" off one another in the adoption of technologies and policies (e g., legislation), thus providing a basis for employing policy-implementing demonstration projects. Patterns of influence and interaction tend to be organized along functional lines, thus lending support to the likely effectiveness of mission-specific demonstration projects. "Gaps" may exist in the continuum of users The experience of the selected site may have relevance for "similar" users, but not for all potential users; thus, questions may arise as to the systemwide impact of demonstration projects compared, for example, with capacity-building programs Demonstration projects do not relate to the goals and decision-making processes of state and local governments. Successful implementation often requires the adaptation of an innovation to unique characteristics at each site--therefore, "it seems unlikely that exemplary projects at selected demonstration sites will be replicated elsewhere "[10] The applicability of any specific transfer approach to a specific setting is heavily conditioned by the specific aspects of the transfer setting, involving such elements as the characteristics of the technology to be promoted or the historical evolution of federal-state-local roles in a particular policy area.[11]

Delivery Mechanisms

Technology Transfer

The terms technology transfer, research utilization, spin-offs and related concepts used throughout this report have been variously defined. Technology transfer, for example, was defined in a National Academy of Engineering Study, Technology Transfer and Utilization, as

> The process of collection, documentation, and successful dissemination of scientific and technical information to a receiver through a number of mechanisms, both formal and informal, passive and active.
>
> The transfer process begins when it has been established that a technological advance has significant relevancy in a directed or different application and that a necessary adaptation can be made. The process occurs naturally between participants who understand what has to be done to permit effective utilization.[12]

A broader definition employed by the Federal Coordinating Council for Science, Engineering and Technology includes "...the collection, documentation, and dissemination of scientific and technological information, including data on the performance and costs of using the technology, the transformation of research and technology into processes, products, and services that can be applied to public or private needs; and the secondary application of research or technology devoted to a particular mission that fills a need in another environment."[13]

These definitions are both too broad at times and too narrow at other times to accurately cover the set of issues contained within this report. They are too broad because they cover in one swoop what

have come to be discerned as different processes involving different actors. Thus, at least for the cast of actors considered in this study, the set of intergovernmental relationships involved in the diffusion of discrete innovations may, in many cases, be different from those called into play in the dissemination and utilization of research findings. To anticipate subsequent discussions, the former process most frequently entails relationships between a federal mission agency and its counterpart at the state and local level; the latter increasingly entails the participation of the governor's office (which is different from a mission agency) or a legislature. Indeed, a central theme of this report is that federal agencies require an improved understanding of the institutional characteristics of decision-making processes within state and local governments. One arena in which these differences most sharply come into focus is in this dichotomy between technology transfer, as narrowly defined in this study, and the utilization_of_scientific and technological information in the policymaking process.

Throughout this report, then, technology transfer shall be used to denote that set of activities (e g , demonstrations, market or user surveys, seminars, newsletters, abstracts, field agents) by which federal agencies seek to foster or promote the use by state and local governments of technologies, broadly defined, developed either by the agency itself or under agency support. Thus, technology transfer as used here tends to be "product-oriented " The set of activities which federal agencies engage in to assist state and local governments acquire improved access to scientific and technological information or to develop the capacity to better understand the scientific and technological questions on state and local government policy agendas

will be referred to as the development of an "S&T" capability within state and local government. From the federal perspective, this latter heading includes those activities generally labeled under information dissemination or research utilization.

A further distinction is made in this report between federal technology transfer approaches which involve the use of field agents and those federal transfer or S&T utilization projects which permit the user to employ a technology transfer or scientific expert. As will be emphasized later, although the roles are often described under the same heading, there are significant differences in the modes of operation of these "external" and "internal" sources.

The initial definitions are too narrow for other purposes in that they omit at least some of the issues (and activities currently engaged in and sponsored by federal agencies) which relate to the question of an effective system of intergovernmental science relationships. Holding aside questions as to what an efficient system looks like, there are growing indications that policies concerning technology transfer will not be set in isolation from broader questions concerning the input of state and local governments into what until recently has been almost total federal domination of the national investment in domestically oriented research and development. For this reason, this study also describes some of the federally funded efforts by which state and local governments have been brought into the design of the federal R&D agendas, most notably in the compilation of "needs-assessments" or "user-oriented R&D agendas."

According to a study by Roessner of federal technology transfer activities, 20 of the 25 agencies surveyed had formal R&D budgets,[14] These 20 agencies spent $231 million in 1975 on technology transfer and research utilization activities, or 4.4 percent of their total R&D budgets. Twenty-four agencies indicated that they were engaged in technological transfer activities which included a variety of approaches, the most important being the use of demonstrations (Table III-2). However, of the total federal agency expenditures for technology transfer, $200 million was represented by the activities of USDA alone (Table III-3).

Descriptions of the specific transfer activities of federal agencies are contained in the Directory of Federal Technology Transfer. Further descriptive material on these programs is therefore omitted from this report.

Information Systems

Information systems relate to activities which seek to promote the spread of information concerning new technologies or the use of S&T information among the user communities. Three principal variants of this approach are of interest here. First, there is the agency-based approach in which an agency seeks to foster the dissemination of research findings arising from its activities to an external set of users. This information service may be provided directly by the agency or through an intermediary. As indicated above (Table III-2), information dissemination and research utilization are staple items within the technology transfer activities of most federal agencies, and have already been catalogued.

TABLE III-2

Type of Technology Transfer Mechanism, by Level of Agency Utilization for 25 Federal Agencies, 1975

Transfer Mechanism	High	Moderate	Low or Do Not Use
Demonstration	15	3	6
Seminars, colloquia	13	10	1
Abstracts	12	2	10
Field agents	12(1)	7(2)	5
Market, user surveys	11	6	7
Newsletters, articles, "advertising"	10	12	2
R&D performer	10	5	9

(1) Seven agency field operations are federally staffed.
(2) Three agency field operations are federally staffed.

Source J. David Roessner, Federal Technology Transfer. An Analysis of Current Program Characteristics and Practices, A report prepared for the Committee on Domestic Technology Transfer, Federal Council for Science and Technology, NSF-76-400, 1975, p. 17.

TABLE III-3

R&D Budget, Transfer/Utilization Budget, and Transfer/Utilization Budget as a Proportion of R&D,[1] Federal Agency, 1975

	R&D Budget ($M)	TT/RU Budget ($M)	TT/RU as Proportion of R&D, (%)
Department of Agriculture	$ 428	$200	47
Federal Highway Administration	17	3.3	19.4
Law Enforcement Assistance Administration	33	4.5	13.6
National Institute of Education	55	5.5	10
National Science Foundation	83	8	9.6
Department of Labor	15	0.5	3.3
National Institute of Mental Health	93	1.8	1.9
Housing and Urban Development	58	0.35	0.6
Environmental Protection Agency	287	1.3	0.45
National Aeronautic and Space Administration	3,327	5.5	0.17
National Bureau of Standards	100	0.1	0.1
Energy Research and Development Administration	712	0.5	0.07
Total	$5,208	$231.35	4.4

Source: Roessner, Federal Technology Transfer, op. cit

The second variation is to establish a multi-agency consortium. The consortium of clearest relevance to this study is the Federal Laboratory Consortium for Technology Transfer. The "labs" consortium began in 1971 as an informal association of DOD laboratories and R&D centers (the "DOD consortium"). By 1978 it had developed into a 10-agency consortium covering 183 laboratories and centers. Administrative and progammatic support has been provided for the consortium through NSF's Intergovernmental Program. Expansion of the consortium led to the creation of six regional groupings, each with a chairman, and to the establishment of a secretariat, located at the China Lake Naval Weapons Center. The consortium has developed its own inventories of personnel and institutional skills. Users seeking assistance can contact the consortium in the following ways: through the individual laboratory and its technology transfer coordinator, through one of the regional chairman, through the secretariat, and through the program manager at NSF.

The consortium has generally been held to be an effective link between the federal government and state and local governments.

One observer has noted,

> the consortium serves as a link between the Labs and the user community, facilitating inter-lab interfaces, brokering solutions for Federal agencies, developing interagency problems for coordinated solutions to problems which fall in the areas of responsibility of other Federal agencies, providing an educational forum through the use of educational materials, workshops, guide books, etc., supporting State and local government programs, encouraging Federal agency cooperation and assisting in the commercialization of relevant products.[15]

The third variant is development with federal support of information systems within the user communities. The Model Interstate

Science and Technology Information Clearinghouse (MISTIC), which is described in the section on State Legislatures, is an example of this approach. Under such an approach, a federal agency contracts with an intermediary to establish an information system which will be used by state or local governments to search for and provide access to scientific and technological information. The basic difference between the first approach described above and this approach is that the former tends to be agency- and activity-specific, whereas the latter tends to be more of a "capacity-building" endeavor which permits the user communities to reach out to a large number of external sources of scientific and technological information, of which federal agencies in general and the agencies providing the funds in specific may be only one possible source.

There are a number of important differences between these approaches Most important, perhaps, is the difference between federal agencies and the users in perceptions of what constitutes "useful" information. The information dissemination programs of federal agencies tend to center around "tech briefs"--short statements of the principal findings from a research study or a project. Much of what is disseminated tends to be directed at assisting the users in their selection of the techniques required to meet federal mandates. This orientation to an information approach appears to work well in promoting the use of new technologies and scientific and technological information in areas where· (a) the "problem" being addressed is largely technological in nature; (b) the mission agency has a high degree of autonomy (from the executive and legislative branches) in selecting policies and

technologies; (c) there is a long tradition of intergovernmental partnership; and (d) there is an extensive network of professional interaction across levels of government. Federal-state-local relationships concerning highways probably best illustrate the "meshing" of the necessary conditions.

Branches of state and local governments other than the mission agency, however, can have information needs different from those of the line agencies, and are likely to perceive the utility of federally granted information quite differently. To begin with, the predominant type of information sought by the executive and legislative branches is not "technological" information as such, but what has been termed policy information. This need has been expressed for state legislatures as follows, but the view is also representative of the executive branch:

> Legislatures need more information to help evaluate legislative proposals and to clarify policy problems. .. (S)olid information on issues would enable legislators to discover components of policy areas and would assist them in evaluating the impact of the policy proposals they are considering.
>
> Legislators also need information indicating options available for confronting a given problem. Such options usually outline program objectives and how to achieve these objectives. This information may be in the form of studies evaluating existing policy in a given state, outlining options, or indicating how other states are approaching similar problems [16]

The information dissemination programs of federal agencies are not designed to provide this type of information. The inevitable intermingling of "technical" and "political" issues in many specific public policy issues (for example, energy conservation or environmental protection), raises questions concerning the utility of "tech briefs" or related workshops. Moreover, much of the technical information offered

by federal agencies relates to policy areas in which the states are being compelled to act under federal legislative mandates. Implementation of these mandates in the form of specific state legislation remains a point of controversy between the federal and state governments. Therefore, federal agencies are not perceived by state officials as "neutral," "disinterested" transmitters of "objective" information, but as advocates for the federal perception of what can or cannot be done in the setting of technically complex and politically volatile issues. For this reason, while information from the federal agencies may be well regarded in terms of its technical sophistication, state or local officials may want to be able to reach out to a broader range of expertise. Rather than simple access to federally supplied information, state and local officials want an information systems capability.

The problems which this preference by state and local representatives creates for federal agencies are obvious. First, single federal agencies (or program managers) are in a sense being required to choose between being responsive to the user communities and internal accountability or evaluation requirements which usually emphasize the number of uses that were made of the agency's output. Single agencies have little internal incentive to develop broad-based, all-purpose information systems among the user communities, and they may encounter difficulty in preserving such programs in internal management or budget reviews. Also, as suggested above, development of such an information capability among the users may tend to increase their abilities to critically assess (and thus to reject or disagree with) information and advice generated by agency-specific information dissemination programs.

How federal agency officials would perceive the utility of such a "user-oriented," "capacity-building" system is an open question.

Another difference between the two approaches bears noting. The agency-specific approach rests on the assumption that the "user" has access to and can assimilate the information made available by the federal agency. Although little in the way of formal study exists on this subject, it seems likely that state and local governments, except possibly for line agencies, suffer both from too little and too much access; that is, those state and local governments with access to national information retrieval systems can receive too much information for the internal decision-making capabilities to absorb, while in other settings, access to information remains a problem. Moreover, the problem of user access is probably less significant than the question of assimilation, interpretation and utility.

Need-Pull

Need-pull relates to those federally funded activities which are designed to augment the capabilities of the user communities to formulate and articulate their needs for technology and/or S&T information. Need-pull is here differentiated from "user input" to denote its separate status as a deliberate strategy of federal agencies. This strategy entails the funding of discrete need-pull projects in contrast to the more continuous if somewhat less formal processes by which federal agencies seek to secure advice and feedback from user communities on their technology transfer activities through a variety of means.

The need-pull approach has emerged in two specific settings: market aggregation and R&D agendas. The first approach is nominally directed at the private sector, but has strong overlap with the technology transfer activities of federal agencies. It involves an effort at developing detailed technical specifications for technologies which spokesmen for the users assert to be needed by their jurisdictions. This combination of grass-roots endorsement coupled with specifications concerning the characteristics of the required technologies is seen as a means of overcoming the fragmentation of the municipal government markets, which, in turn, is seen as a major barrier to private sector investment in research and development programs

The R&D agenda approach rests upon the view that the limited utility of technology transfer or information dissemination programs stems from the fact that these programs occur too late in the research-development-diffusion (transfer, dissemination) cycle. The user's contention is that the problems being addressed are not those of major concern to their communities. More specifically, the charge is often made that federal agencies seek to solve "national" problems in their "R&D" agendas, whereas, in fact, these problems consist of a great number of highly localized, specific variants of these problems. The consequence of this disparity between the general and the specific is that the solutions generated via a federal agency's activities are of little relevance to the user communities Given this mismatch, it makes little difference as to how well-intentioned or sophisticated the technology transfer or information dissemination program of a federal agency may be for it is attempting to promote an unsuitable output.

The perceived remedy for this mismatch is to have the user communities enter early into this cycle by having them state and rank their problems. User-oriented "R&D" agendas would then become part of the internal federal agency R&D agenda setting process, and presumably would lead to an output which could be transferred and disseminated more readily because it met the users' previously stated needs.

User-oriented agenda building has now become a major activity in intergovernmental science relationships. As noted earlier, ISETAP is currently engaged in such agenda building with representatives from state and local agencies; representatives of state and local associations are similarly engaged in this line of endeavor under project grants from the National Science Foundation.

There has been no assessment to date of the impact of either type of need-pull activity. Market aggregation objectives are included in the overall objectives of the Urban Technology System, and are a principal objective of the Urban Consortium project. The UTS project will be evaluated in late 1978, so some assessment of the effectiveness of the market aggregation approach should be available shortly. User-based R&D agendas are just now being developed; assessment of their impact, that is, the extent to which they do in fact influence federal agency programmatic priorities, is premature.

Caution, however, would seem to be in order concerning the impact of either of these approaches. The line between user input, "needs-assessment," and "demand-pull" is often imperceptible; nevertheless, it is an important demarcation. Studies of R&D, diffusion, and transfer processes share a common conclusion in noting that "success" requires that market (demand) influences strongly affect the likelihood

of an innovation being adopted. Marquis and Meyers summarize the findings concerning the conditions for successful innovations as follows: "Although the initiation of an innovation depends on a fusion of the recognition of a demand and of a technical feasibility, the primary factor in the successful innovations studies was market related in 45 percent of the cases, production related in 30 percent, and technical in only 21 percent."[17] A recent study prepared for the Office of Technology Assessment on federal demonstration projects, for example, notes that. "User need, as exemplified by nonfederal initiative and cost/risk sharing, is an important factor in the success of policy-implementing demonstrations."[18] While the widespread dissatisfaction with the results of transfer projects operated strictly in the "push" mode would seem to leave little doubt as to the importance of user input in developing effective transfer programs, it does not follow that the type of activities currently engaged in are effective or meaningful ways of articulating these needs or achieving these inputs. Again, it must be emphasized that it is too early to conduct formal assessments of projects conducted in this mode Still, it appears that these projects appear to be overly preoccupied with the mechanics of compiling user-need agendas, and somewhat thin on focusing on the development of a system of incentives between the supplier and user communities which would lead to a continuing and more interactive set of discussions than that which is suggested by paper agendas.

S&T Agent

By S&T agent is meant an individual or organizational unit located within the user institution that is specifically assigned to procure S&T information relevant to the needs of the user. While the tasks performed by such an agent closely parallel those typically described for field agents or otherwise performed during the transfer dissemination activities of a federal agency, the key element of this approach is that the agent is part of the user institution. As such, the agent is accountable to the user and generally can be expected, in the case of S&T information, to "interpret" the information in a manner which is comprehensible and accessible to the user, and, in the case of technology transfer, to have a fuller understanding of the complex set of factors which enter into the user's decision to adopt and to implement than is typical of a federal agency or other type of supplier.

Several other characteristics of this approach have made it increasingly attractive to the user communities. First, as noted, it permits the user to select the individual(s) who will serve as the link to the external S&T communities. The importance of this role is related to the perception of the user that scientific and technical information is neither useful in the abstract nor is likely to be neutral with respect to the set of issues which the user is confronting. This view is best stated in Howard Margolis' dicta on the elusiveness of objective advice.

> There is no such thing as objective technical advice in the sense of an assessment of the technical issues in a policy controversy which will be acceptable to all parties as a fair and adequate statement.[19]

This recurrent intermingling of "technical" and "political" aspects of policy issues induces users to seek information sources which they can rely upon to share an awareness of or sensitivity to Margolis' observation rather than sources which tend to focus on (uniquely) technically correct solutions. Second, an internal capability permits the user to reach out broadly to the external scientific and technical communities and does not make it dependent upon the expertise of a single agency with whom the user is possibly in conflict. Third, the internal capability gives the user a "pro-active capability" to search out improvements in existing practices without having to wait until issues reach a "critical stage " Fourth, the internal capability meshes more closely with the complex, often iterative sequence of rounds, often encountered in the technology transfer-information utilization process. The agent is available to the user through the several rounds of deliberation, negotiation, decision, last-minute adjustments, and implementation that are likely to be coursed in making decisions on complex issues. The importance of an agent in this last aspect is perhaps best illustrated not by citation of state or local experience in the S&T field but from an analysis of the role of science advisors at the federal level.

> ...government, like all other human activities is a process, and it is a process made up of a very large number of steps . What really bends the processes of government is continuous, sustained, and intensive effort, generally uncertain at the beginning of what its exact final outcome will be, always responsive to the situation as it is, and continuously aware of the need to be on top of <u>that</u> situation, and not of some abstract plan of what it ought to be, or was when one once knew it, or would be if only the people in Washington had more sense.[20]

There are, however, several problems associated with the use of S&T agents, including cost, organizational placement, and recruitment. Most important of all is the recognition on the part of the user that such a capability is needed. The literature on organizational change places great emphasis on the concept of "performance gap," the action-stimulating recognition on the part of the organization that performance is falling short of some required goals (e g., sales, profits, budget).[21] The baneful consequences of low levels of performance or incorrect or short-sighted decisions, however, are not always readily apparent in the performance of state and local governments. For this reason, one of the major obstacles to developing a long-term awareness within state and local governments of the benefits from an ongoing internal capability to search for and evaluate scientific and technological developments is to obtain the initial installation of such a capability. Once in place, the S&T agent provides the user not only with specific bits of S&T information, but (potentially) with a different perspective on what type of information is available and on the range of information sources available to it (the user).

Employment of an S&T agent either to foster a more extensive adoption of new technological practices or to serve as a link with the external scientific and technological communities entails creating and funding a new staff position within the user community. Creation of such a position also implies that existing organizational units are not performing adequately. The very set of incentives and organizatonal characteristics which are widely held to lead public sector organizations to perform less efficiently than private sector organizations work against

the allocation of resources by these communities to new performance-enhancing or problem-solving capabilities. Moreover, even if so inclined to employ such capabilities, their concern over a political backlash from hiring additional staff appears to constrain their willingness to augment their internal capabilities.

Questions of the scale of operations also affect the attractiveness of this approach. There would appear to be some minimum scale of operations necessary before cities or branches of state government would find employment of specialized S&T agents more efficient than alternative means of receiving the same type of service (e.g., consultants, information clearinghouses). For example, when data from a nationally representative survey of state legislative preferences for improvements in information systems were related to the legislators' assessment of the adequacy of the existing information systems, a developmental continuum emerged in which preferences for specialized S&T agents appeared only after legislators felt that their general, all-purpose information needs were being met[22] (Table III-4)

Extending this finding to the other branches of the user communities with which this report is concerned, it appears that the appeal of an S&T agent is dependent on the user's general sense of satisfaction with its overall problem-solving abilities. There also are likely to be differences in the characteristics of those users who are willing to employ S&T agents when these agents are underwritten by federal programs funds and those who are willing either to initiate S&T agent programs from their own resources or who are likely to continue to support the agents after a federal seed money program ends.

Given that a user adopts the S&T agent approach, the question arises as to the placement of such an agent within the user's organization. The significance of this question arises from the fact that

TABLE III-4

Developmental Continuum of State Legislature Preferences for Scientific and Technical Information Mechanisms

Phase	Type of Reform (Personnel)	Objectives of Reform	Examples
I	Centralized Liaison (generalists)	Delegate general liaison task to a central staff.	Conventional Legislative Reference Service or Legislative Council
II	Centralized Processing (generalists)	Delegate general processing to a central research staff.	Research staff within Reference or Council staff.
III	Decentralized Liaison (generalists)	Develop broadly accessible liaison mechanisms to supplement centralized liaison arrangements.	"Referral offices" within state agencies to handle legislators' requests for information
IV	Decentralized Processing (generalists)	Give committees, parties, or individual legislators processing capability.	Committee research staffs, research assistants for legislators, conventional student intern programs.
V	Centralized Liaison (specialists)	Develop liaison with "experts" on centralized basis.	Intralegislative scientific and technological information clearinghouse, legislature-university information clearinghouses
VI	Centralized Processing (specialists)	Develop centralized intralegislative processing capability by hiring specialists to the central staff.	Science advisors to legislative leadership, scientists or engineers on central research staff
VII	Decentralized Liaison (specialists)	Supplement centralized liaison with specialists by means of broadly accessible liaison mechanisms	"Access points" in state universities to refer legislators requesting information to appropriate faculty member.
VIII	Decentralized Processing (specialists)	Develop specialized expertise on committee or personal staffs	Add scientists, engineers, etc., to committee/personal staffs, scientifically trained student interns.

Source Irwin Feller, Michael King, Donald C. Menzel, Robert O'Connor, and Peter Wissel, Sources and Uses of Scientific and Technological Information in State Legislatures (University Park, Pa.: Center for the Study of Science Policy, 1975).

the S&T agent is in essence a "change agent," and as such cannot but help disrupt existing internal patterns of communication, influence, and authority. The tension created by the employment of S&T agents arises within each of the major user communities. At the municipal level, the tension is most often found between the line agency, the traditional locus of decision making on matters concerning the selection of new technologies and the traditional source of technical information, and the executive branch of municipal government. There is little doubt that many of the major urban technology transfer programs are predicated on the assumption that line agencies are excessively tradition-bound and cannot be relied upon to search for and to adopt new practices. This has led, as in the case of the Urban Technology System, to the general placement of S&T agents within the mayor's or city manager's office. Such a position gives the agent visibility and access to the central decision maker. However, the position may also serve to isolate the agent from the line agency, which in most cases will end up with responsibility for implementing new, functionally-directed practices, and indeed may tend to create adversary relationships between the agent and the line agency.

Within the executive level of state government, there are likewise potentials for conflict depending on whether the agent is seen as serving the line agency or the governor. Until recently, federal programs for state governments have tended to operate on the assumption that there was an equivalence between the two components of state government. More recently, however, the "policy analysis" representives of governors' offices have argued that such is not the case, and indeed that federal programs designed to assist state governments have tended to undermine the independent policymaking positions of governors:

> ...scientific and technical expertise within line agencies oriented around functional responsibilities, is not a substitute for scientific resources at the gubernatorial level. To be sure, one should not be developed at the expense of the other. But in most cases the growth in scientific and technical sophistication has occurred deep within operating departments, without a corresponding expansion within central management. Partial responsibility for this pattern of development lies with the federal government, for the enormous subsidy given line departments in return for the administration of federal programs has not been balanced by federal investment in central management mechanisms upon which the governor must rely to carry out policy management responsibilities Whatever the reason, governors who are beset with demands from a sometimes irate citizenry to get control of the bureaucracy find themselves without the capacity to judge the claims of special interest groups or to challenge the conclusions of line agencies because they rest upon scientific or technical arguments that are beyond their own competence. Under a healthy system of policy management, governors would have access to resources that are independent of line agencies, both because they must be equipped to assess the validity of policies that are proposed by these agencies and because they must confront issues that span several agency jurisdictions.[23]

At the state legislative level, the placement of the S&T agent generates issues both of access by the majority and minority parties to the services of the agent, and, within the majority party, of access by both the leadership and the rank and file. The underlying issue is the same in both cases: control of information is an element in forging political power and influence. An organizational arrangement in which an S&T unit is responsible to the leadership of the majority party implies a significantly different distribution of influences than an arrangment in which the unit is readily available to all members of all parties.

Finally, the issue of recruitment of S&T agents should be noted. The above discussion implies that the skills needed for the successful

exercise of such a role involve, at a minimum, sufficient technical competency to be able to communicate with the scientific and technical communities and an understanding of and sensitivity to the organizational consequences of introducing change agents in environments described as resistant to change.

The limited evidence to date on recruitment is encouraging. The legislative S&T organizations now in place in several states (e.g., Wisconsin, Illinois, Pennsylvania, Minnesota) represent new career tracks for scientists and engineers in the public sector. The Urban Technology System similarly provides a new occupational slot, that of technology agent. These positions are of too recent a vintage to permit any firm conclusions as to their permanence or whether their existence has induced lasting changes in the educational curriculum within the universities and professional associations which foster the development of the skills and training useful in these positions.

Little is known about the ability of state and local governments to recruit S&T personnel from the scientific and technical communities to work on specific state or local problems. Personnel exchanges have been facilitated through the Intergovernmental Personnel Act, and have been arranged in other ways, such as leave arrangements for faculty to work with state government. Governors seem to have had little difficulty in attracting academic or industrial scientists and engineers to serve on a volunteer basis on science advisory boards. The issue is not so much one of administrative arrangements for ad hoc assignments as it is to provide incentives to members of the scientific and technical communities to accept assignments as S&T agents within state and local governments. For example, under a grant from the National Science

Foundation, the Pennsylvania House of Representatives has established a Legislative Office for Research Liaison (LORL), which has a core staff of one full-time scientist and supporting personnel and a staff of three faculty members on leave on a rotating basis from six Pennsylvania universities. In its first two years of operation, LORL has experienced little difficulty in attracting faculty members to apply for these positions. There is, however, little evidence on how these experiences have contributed to the professional careers within the university setting of those faculty who have been involved with LORL It seems doubtful that the stream of applications will continue unless this activity is recognized in normal university tenure, promotion, and salary decisions, except for those individuals who see such service as meeting their own personal or professional goals.

Similar questions arise with the weights assigned within federal agencies to the activities of those of their personnel who participate in exchange-programs with state and local governments. Again, unless participation in these activities is treated on a par during personnel reviews with the activities which such personnel would otherwise have been involved in, the intergovernmental personnel exchange stream can be expected to dry up.

Delivery Channels

This report also considers six channels through which the four techniques can be delivered: federal agencies, the user agency itself, and four intermediaries--universities, professional associations, consortia, and networks. Descriptive information on how these channels are employed and on the issues relating to their use is presented in

Sections IV - VI. Of interest here are the more general issues relating to decisions concerning the use of two-party or multi-party arrangements for delivering technological innovations or scientific and technological information.

The heading of user agency performer is used to denote those programs in which the federal government provides funding support directly to a user, who then uses these funds to either acquire a technology or to employ the scientific and technical personnel it deems necessary to develop an internal S&T capability. The use by states or cities of categorical grant-in-aid or general revenue sharing funds to acquire new technologies is an example of the first outcome, the use by these user communities of federal project grant funds to employ technology agents, as in case of Tacoma, Washington, or to hire scientific staff, as in the case of the New York Assembly, illustrates the latter outcome.

The heading of federal agency performer denotes those activities in which a federal agency is the supplier of a technical assistance service. These activities would include demonstration projects, information dissemination programs and training programs. The key element of these programs, from the perspective of this study, is that they involve direct federal-user interaction beyond the provision of federal funds.

Although it is difficult to quantify the magnitude of the change, it appears that direct federal user interaction in either of the two forms considered above is being, if not displaced, then at least supplemented by a process of intermediation. The basic characteristic of this process is that the federal government provides financial

support to an organizational entity which, in turn, provides a service to the user communities.

Four elements appear to enhance the appeal of the intermediation approach. (1) It has the potential for being cost-effective in that it fixes federal outlays to the amount of a specific grant, substitutes lower cost state and local personnel for federal personnel in the delivery of a service, and in some cases capitalizes on already existing delivery channels. (2) The approach appears to have worked well in some areas. A notable example here would be the set of relationships that exist among the Federal Highway Administration, the American Association of State Highway and Transportation Officials and the Highway Research Board. (3) It provides an economical, single point for the translation of federally-generated information into langugage and formats more compatible with the needs of the users. (4) It introduces an organizational entity allied with the user communities into an environment possibly characterized by lack of confidence or credibility in federal-user relationships, or indeed one of open adversarial relationships.

These four elements relate to issues of federal-user relationships An independent push for such arrangements has come from the scientific and technical communities, most notably from state-supported universities and from professional engineering associations, such as the American Society for Mechanical Engineering. A substantial amount of this interest on the part of the academic and engineering communities for greater involvement with the scientific and technical issues of state and local governments can be attributed to the decline in federal funding for research and to the decline in employment for scientific

and technically trained personnel that occurred in the late 1960s. The availability of what appeared to a "surplus" pool of technically trained personnel juxtaposed against the claims that state and local governments had needs for such skills gave the meshing of the two situations considerable allure.

Changes in attitudes and values are difficult to gauge. Moreover, attitudes and values of individuals or groups may change, but the policies, rewards, and sanctions of the institutions within which these individuals operate may not, thus retarding the transition from changed values to changed behavior. With these strictures in mind, it does appear that there have been important changes in the attitudes of the scientific and technical communities as to the importance of the scientific and technical needs of state and local governments and as to the professional legitimacy of the work directed at these needs undertaken by members of these communities. The change may amount only to a transition from disdain to acceptance (as compared with endorsement and encouragement), and may appear only in subsets within specific scientific and technical communities. The importance of these changes, however, should not be overlooked, because they suggest that the emergence of the use of intermediation as a federal policy derives not only from considerations of effective arrangements for intergovernmental relationships but also from changes within the scientific and technical communities.

Two general types of intermediaries are described in this report. First, there are the existing associations of state and local governments, such as the National Governors Association, the National Conference of State Legislatures and the International City Management Association. Second, there are the newly created intermediaries,

such as Public Technology Incorporated or the New England Innovation Group. In the first case, existing organizations have taken on expanded roles. Their involvement in the promotion of technological innovations or of scientific and technical information represents part of the general broadening and upgrading of the services they perform for their constituents. In the second case, new organizations have been created to fill what are perceived to be "gaps" in existing systems for delivering technological innovation to a specific set of clients. Most of the activities of the new organizations are supported by project grants from federal agencies.

The last 10 years has shown a rapid increase in both the number of intermediaries and in the number of projects conducted by both old and new intermediaries. The combination of performers and project activities do not permit easy categorization or evaluation In a very important way, the variety of approaches and activities currently under way is consistent with findings emerging from studies of innovation and information dissemination processes in state and local governments which have highlighted the "specific" local interplay of factors which determine whether or not a project is successful. From this perspective, the array of activities may represent the aggregation of a set of independent approaches, each of which has been appropriately tailored to its local situation. A general assessment of this use of intermediaries is also difficult, because, as noted earlier, so little of the activities currently under way have been subject to any form of evaluation. These qualifications aside, it does appear that the federal government has placed itself in a situation where it has created a large number of

organizations which are heavily dependent upon continued federal support for their existence without much systematic analysis of what the total combination of activities is designed to accomplish or, to date, has accomplished.

Footnotes

[1]Gordon, A Study to Review and Analyze Federal Effects, op.cit.

[2]Irwin Feller and Donald C. Menzel, Diffusion of Innovations in Municipal Governments, (University Park, PA - Center for the Study of Science Policy, 1976) Report to the National Science Foundation, Grant DA-44350, p.215.

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Section IV

State Executive

Overview

The design of programs to promote the increased use of scientific and technological knowledge by the executive branch of state government entails the greatest degree of complexity of any of the three levels of government considered in this report. This complexity derives from three sources: (1) the state executive branch is involved more deeply in the separate elements of the intergovernmental science system (e.g , R&D priority setting, technology transfer) than are the other two branches and is involved with issues which are not major concerns of the other branches (e.g , R&D funding); (2) the number and size of the different organizations which are involved in the generation and utilization of scientific and technological knowledge is larger than for the other two branches, so that issues of coordination and control, as for example, among a line agency, the budget office, and the governor's office, become relatively more important as elements in the implementation of successful projects; and (3) the executive branch has a more complex history of previous efforts to utilize scientific and technological knowledge which may now constitute a barrier to eliciting renewed executive interest in federal programs.

Although the issues contained under the above headings extend beyond the specifics of technology transfer programs, analysis of their characteristics may be of value in understanding the full

range of S&T-related activities conducted at the state executive level and the organizational and administrative arrangements within which these activities are conducted. Three separate activities are described in this section: state R&D expenditures, technological adoption and implementation, and scientific and technical information.

R&D Expenditures

From a state perspective, R&D expenditures represent an alternative to reliance on the federal government for new technologies. This approach has been little used to date and is not likely to become important in the near future. However, it does represent a potential state option if dissatisfaction with federal policies surfaces, and as such must be considered

R&D expenditures are an insignificant portion of state expenditures, amounting in the aggregate to less than one-half of 1 percent of total state expenditures. State expenditures for research and development totaled $235 million in fiscal year 1972 and $264 million in fiscal year 1973, the last years for which complete survey data are available. (Data for fiscal year 1977 should be available by mid-1979, as the National Science Foundation has reinstituted a survey of state R&D expenditures.) It is doubtful if state expenditures in real dollars increased after FY 1973, except probably for an increase in expenditures for energy-related subjects.

In terms of summary descriptors, state R&D expenditures can be characterized as follows. Approximately one-half of the total state

R&D expenditures derives from federal funds. Two states account for approximately one-third of total state outlays (New York--23%; California--13%), while 15 states account for three-fourths of the total. These states tend heavily to be the larger, industrialized states. Expenditures for health and natural resources account for 35 percent and 22 percent of state R&D expenditures. Slightly over two-thirds of total R&D expenditures are allocated for intramural work Universities (12%) and other performers (20%) such as industry, nonprofit institutions, and local governments account for the balance. About one-third of the state R&D effort is directed at applied research.[1]

The relatively minor importance of R&D expenditures within the states is mirrored in the general lack of attention and, indeed, of interest directed at producing at the state level any semblance of an R&D budget. Studies of the R&D decision-making and expenditure process at the state level have indicated that little attention is paid to R&D as a separate budget category. Decision making concerning priorities and performance tends to be highly decentralized, even diffuse R&D activities and thus R&D management approaches are likely to be found not only in a department's R&D division, if one exists, but in many units. This decentralization at the division level is replicated at the central administration level, where little need is felt to construct state-level R&D plans or to coordinate R&D activities among departments.

Feller, writing in 1971, contended that little was known within state governments not only of what R&D activities were being conducted but also of the payoffs to the states of the activities being funded:

> ....State R&D activities and the associated administrative structures are likely to be diffused and fragmented. Where performed or contracted for within a department, research generally has only a limited role. State R&D is likely to be directed at marginal improvements of the status quo. Problem-solving research is likely to be undertaken only in terms of crisis situations and not to solve developing or anticipated problems. Research is not viewed as a separable program leading to increased public welfare, economic development or more efficient government operation and control, as other programs presumably do The fragmented nature of state R&D is based upon organizational diffuseness and budgetary pressures which compel research administrators to select short-term projects directed at marginal improvements of existing practices.[2]

State budget officers have indicated little interest in research and development as a separate objective, which is perhaps not surprising, but also little interest in R&D as a discrete activity As noted in the 1975 report of a Task Force of the National Association of State Budget Officers,

> The terms "science," "technology," and "research and development" are not part of the budget glossary of buzzwords Nor, while they are important to state government, should they be. These are not ideas the budget officers feel they should be promoting. They are already promoting many concepts, analysis, evaluation, effectiveness measurement, management improvement, productivity, and others. Research and technology are seen as methods to achieve maximum use of these other concepts, and should not be isolated for separate promotion.[3]

Technology Transfer

Technology transfer, from the perspective of state governments--the relevant users--is a process of adoption and incorporation. Surprisingly, although technology transfer has been the subject of extensive conceptual and descriptive study, far less attention has been

directed at examining the processes within state governments that lead them to accept, modify or reject technologies This section draws upon recent studies on the adoption/diffusion/implementation process of technological innovation in state governments. Particular emphasis is placed on two themes which relate directly to the design of federal technology transfer policies: the complex set of relationships in which federal agencies and branches of state government relate to one another in those fields in which federal agencies are seeking to promote the use of technologies, and the relationships within state government of the various units involved in decisions to adopt new technologies.

The adoption of new technologies in state governments has been found to generally involve a small number of career officials and technical staff within the mission agencies. Indeed, most federal technology transfer programs are predicated on this agency autonomy, as for the most part they represent a form of vertical networking between federal agency and state agency personnel. The extent to which federal agencies are able to influence the rate and selection of specific technologies has been found to involve more than the characteristics of any given technology transfer program. Rather, state acceptance of federal guidance is affected by a broader set of intergovernmental relationships involving legislatively defined mandates for action, intergovernmental assignments of jurisdictions and responsibility for specific courses of action, funding arrangements, and mobility of personnel among levels of government. These variables are in turn greatly affected by the evolution of channels of communication between federal and state agencies, which themselves are a function of clearly defined spheres of responsibility, and demonstrated reciprocal credibility and usefulness.

The findings from a 1976 study on the diffusion of innovations in state mission agencies and the changes that appear to have occurred since then illustrate these points. In their assessment of the federal influence on the diffusion of technology in state highway and air pollution control departments, Feller, Menzel, and Engel concluded that this influence was "indisputable but not all-pervasive."

> Neither federal legislation nor edicts by federal agencies necessarily guarantees the adoption of new technologies by state mission-oriented agencies...the relationship is a mutual one marked by a measure of 'give and take.' An imbalance in this relationship does not appear to be conducive to the transfer of technology. The contrast between the federal influence in the highway-transportation field and that in the air pollution field is illustrative. State highway-transportation agencies are heavily influenced by the FHWA but, at the same time, heavily influence the FHWA. A degree of tension exists and has the effect of crystallizing opinions on new technologies.
>
> This condition does not appear to exist with regard to the Environmental Protection Agency and the states A two-pronged problem exists. On the one hand, the states are willing to be influenced by the EPA, almost to the point of submission. On the other hand, the EPA is prepared to influence the state but is somewhat hesitant to do so. The consequence for the transfer of technology is that the states, for the most part, tend to be cautious and conservative. The risks associated with using new technology are sufficiently great to discourage adoption in many cases.[4]

These findings, in essence, contrast relationships in two fields which differ by almost 50 years in the duration of federal-state relationships. In the early 1970s, those states whose activities antedated federal efforts in the air pollution field, such as California, New Jersey, and New York, regarded themselves as the technical peers

if not the superiors of federal officials. Relationships between the two levels of government had strong adversarial overtones. Interviews conducted in 1978 with manufacturers of air monitoring equipment indicate that the milieu in which adoption decisions are made has changed EPA is judged to have improved its own internal capability to evaluate and to disseminate information on new air pollution control equipment, and its advice is held to be more favorably received by state governments than in earlier years. Indeed, the contrast made above between the internal coherence and intergovernmental acceptance of different federal agencies is today made within EPA between its air quality and water quality programs.

The differences among fields in the acceptance by state governments of the technology transfer activities of federal agencies and the changes in the acceptability accorded to any single federal agency over time thus rests on more than the transfer activities themselves. A necessary condition for acceptance in a particular functional area appears to be that the federal government has achieved acceptance by state and local officials, particularly when the federal efforts involve an expansion of its role in areas historically under the jurisdiction of subnational levels of government. This requirement is based on more than state or local opposition to federal inference. It reflects the state and local view that their ability to conduct activities in a functional area is hampered once the federal government involves itself because of the confusion and delays often associated with federal entry. Again, state experience with EPA has been cited in this regard: "Staffs with long established programs felt that the intrusion of the federal government into their ongoing programs cost them about two years of

agency time in adjusting their procedures and programs. As a result, they were not able to move forward or to make progress."[5]

Although less well documented, the relative degrees of competency between federal and state agencies also appear to have influenced state acceptance of federal technology transfer efforts. While a substantial portion of the rationale for federal technology transfer efforts rests on the assumption that federal agencies, as a result of either their intramural or external R&D programs, will tend to be more technologically advanced than state mission agencies, there appears to be some meaning to the concept of an "optimal degree of tension." Too great a gap in the levels of technical competency between the federal and state agencies increases the likelihood that the federal R&D program will result in outputs which are ill-suited to the needs of the user agencies. In such a setting, it is likely that the users will not be able to employ the technology without additional personnel and that the technology will not be operated close to its potential levels of technical performance. Too small a gap or a reversal of roles may create a situation where personnel and/or organizational issues of technical rivalry become so intrusive as to divert attention away from specific technologies.

Federal efforts to promote the use of technologies may thus require an antecedent or complementary investment in the capabilities of the state personnel who are to operate and maintain the technologies in question. Training programs and seminars are a staple component of many federal technology transfer programs. These programs, moreover, have been found to be an important source of information for state officials. It may be, however, that these efforts do not reach deeply enough or broadly enough into an agency to induce it to acquire a

new technology, particularly when adoption is less a matter of the capability of an existing staff to comprehend the characteristics of the technology than of the agency's ability to acquire the additional staff necessary to adequately operate it. Thus, Hackbart and Patton in their study of innovation in state government processes single out staff shortages and work overload as one of the three major impediments to innovation.

> Almost every state interviewed contended that they were seriously understaffed, staffed with unqualified personnel, or both.[6]

In addition, salaries for technically trained personnel remain below competitive market levels in some, if not all, states Not only do these low salaries make it difficult for states to recruit the personnel they need to handle new, complex technologies, but some states also have experienced high turnover rates as the junior staff use their stint as state employees to acquire on-the-job training before moving on to higher salaries in private industry or other levels of government

Finally, the question of the participants in the decision-making process again surfaces. Although the degree of autonomy that state agency officials have in acquiring new technologies has been found to be quite high, it is not complete. The degree of autonomy possessed by an agency depends, in part, on the characteristics of the technology being considered. Moreover, the overall degree of agency autonomy may be decreasing, particularly, as state legislatures reassert their independent role in scrutinizing state expenditures. As for the first point, the extent to which decision making concerning a new technology remains the province of senior agency officials appears

to depend upon the cost of the technology, the extent to which it is perceived as a replacement for existing equipment or as representing a new system (including possibly an expansion in the scope of state services), and what might be termed the "authority" or "track record" of the agency or of its senior personnel. There is little in the way of detailed evidence on the relative or total importance of these characteristics of the technology, but again, it appears that one of the issues that must be confronted by federal agencies either in designing agency-wide technology transfer programs or in attempting to promote adoption of a specific technology is the extent to which they can assume that decision making will remain within the agency. From the federal perspective, the quandary is as follows To exclude the relevant extra-agency decision makers when they are important is to run the risk of having the transfer process hit a stone wall once the question of the technology leaves the agency; to include them when they are not significantly involved is to introduce potential new delays or otherwise avoidable barriers. At present, except possibly for the "experience" of federal agency personnel, there is little in the way of firm guidelines or state-specific information which a federal agency can follow in seeking to promote the use of specific technologies by state governments.

Scientific and Technical Information

The emergence of state executive requirements for scientific and technical information as a discrete category of information needs occurred in the early 1960s. This development reflected, in part, the

replication by states of developments then under way at the federal level, which included the designation of a presidential science advisor and the establishment of a President's Science Advisory Council. In part also, it reflected the efforts of several states to garner the economic benefits associated with research and development activities as then illustrated most prominently by the prosperous high-technology areas around Route 128 in Massachusetts and Palo Alto, California This association led several states to fund state science and engineering foundations which were to seed those research areas which were judged to have high potential for stimulating economic growth.

The history of the state science advisory movement has been described in several places, originally in Harvey Sapolsky's[7] critique of this movement and more recently in Duga's description of the organizational characteristics of the science advisory mechanism.[8] The general tenor of the original critique by Sapolsky was that this approach was of limited value. In most states the science advisor to a governor was considered to have had largely symbolic value, denoting the governor's progressivity and willingness to listen to the advice of scientific and technical communities. However, in the day-to-day formulation of policy, the science advisor or advisory group had little impact on policy. When clearly delineated scientific issues came to the political forefront, the governor was more apt to turn to trusted advisors or to other members of the scientific and technical community than to the individuals on his official board. The efforts by states to stimulate their economies through technologies was similarly held to be an "uncertain path" to economic growth.[9]

The recent efforts by the state executive branch, as reflected in activities undertaken under the State Science and Engineering Act,

to articulate its need for scientific and technical information have shown a greater awareness than that which was exhibited in the earlier efforts to link technical information, or perhaps more accurately, technical sources, to the policy process. The questions of magnitude of the needs of the executive branch for scientific and technical information and whether these needs have increased over the years remain unresolved Certainly, there are widespread statements of the increasing complexity of American society, as well as an increased awareness of the need for public decision makers to consider second-order consequences, externalities, and delayed impacts. It is difficult, however, to obtain a meaningful measure of these trends and of their consequent impact on the elements that enter into state policymaking. The number or percentage of bills introduced into the state arena which have a scientific and technical component depends on the operational definition attached to science and technology and the extent to which definitions are compatible with the way in which the state official defines the issue.

For present purposes, precise estimates of the magnitude of the executive's needs for S&T information are not needed. The more important aspects of these considerations are, (1) that there is a need for information, (2) that the information is likely to be needed on issues not already present on the state's policy agenda, so that when the need arises it is likely to be in those areas in which the state does not have in-house capability to which it can readily turn, and (3) that the information be accessible and comprehensible to the policymaker. In most cases, this means that the technical material be translated from the finer technical aspects of the issue to discussions of the benefits

and costs of alternative courses of action that the executive might propose to take and the distributional impact of these actions. This approach to the use of scientific and technical information is in keeping with the way the executive branch defines and confronts issues; it is not necessarily compatible with the view of the scientific and technical community as to how their information should be sought or utilized.

Moreover, there is a continuing debate on the placement of information within the executive branch. From one perspective, it is most desirable to provide the information directly to the chief decision maker, namely, the governor. However, it is not readily apparent either that the governor has the time to listen or to work through the technical aspects of controversy himself or that the range of issues which entail scientific and technical components are necessarily decided by the top executive alone. Finally, there is a problem of developing a system of information which can be viable over the term of a governor and possibly survive the transition from one governor to another. There are trade-offs here between impact and permanence. A consensus, at least among those who are responsible for shaping state executive policy, seems to emerge about two, not necessarily consistent, conclusions. (1) Establishment of S&T information systems within the state executive branch may be more effective and advisable if they are organized as part of an ongoing policy apparatus, and not, as in the past, as part of the science advisor or science advisory approach. (2) The organization and placement of scientific and technical information in the executive branch will vary from state to state, with the "best" solution depending heavily on local

institutional arrangements and the style of the particular governor being considered.

There is the further issue, noted earlier, that the state executive branch consists not only of the governor but also of the executive agencies. Indeed, the Helminski and Muchmore statement cited earlier suggests that the tendency for federal agencies to relate to their counterparts at the state level, at least in the eyes of those who work for the governor, has created an imbalance between the technical competency of the line agencies and that of the governor's office. This has created two problems: (1) the policies of the governor and those preferred by agency officials may not be consistent, (2) the information provided through this vertical network tends to be functionally organized as to the way issues become defined, whereas the governor may see his role as requiring a course-cutting perspective where he must balance the claims and objectives of competing functional agencies within his administration and between the governor's office as such and the line agencies.

The importance of these strains depends upon the political situation within any given state and the likely mix of issues, so that little in the way of specific prescriptions for the design of federal technology transfer programs is possible. This issue, however, of the placement of information within the executive branch can create serious problems for federal agencies. To the extent that governors rely upon in-house officials for advice on policy issues, the arrangement of federal agency efforts to channel technology and scientific information to state agencies provides a plausible and efficient

means for effecting an intergovernmental transfer of knowledge. Where, however, intrastate relationships are not good, the federal agencies may find themselves in a position of being viewed, at least by the governor, as a source of information to his policy adversaries within his own borders. Although cause-and-effect relations cannot be clearly determined because of the absence of systematic studies of how governors obtain information, it would appear, however, that the recent upgrading of the National Governor's Association and its regional counterparts represents an effort, at least on the part of some governors, to develop a staff capability on technical issues which is more clearly directed to the governor per se than to the state executive branch. Thus, for example, NGA's current energy project not only fills the gap that existed in the absence of state energy offices, but also more clearly provides a perspective, involving such issues as powers, authorities, and responsibilities under alternative state approaches, which governors may feel is absent from the energy plans of federal or state mission agencies

Specific Approaches

Table IV-1 classifies some representative projects undertaken to promote the transfer of scientific and technological knowledge to the state executive branch. These projects represent discrete efforts at promoting such transfer, and, as such, are in addition to ongoing federal agency technology transfer and information dissemination activities.

C-2

TABLE IV-1

Classification of Project Approaches: State Executives

Delivery Mechanism: Technique \ Channel: Intermediaries	State Agency	University	Professional Organization	Network	Consortia
S&T Agent/Advisory Council	Center for Science Policy and Development (Hawaii)	Michigan Executive Science Advisory Project: Phase II			
Information System			National Governors' Association Project National Governors' Conference: Governors' Energy Project	Coalition of Northeastern Governors (Conn., Mass., New Jersey, New York, Pa , Rhode Island)	
Technology Transfer			Council for State Governments Innovations Transfer Project		Pacific Northeast Innovation Group Experimental Federa State Technology Transfer Mechanism (Louisiana and Mississippi)
Need Pull			Midwestern Governors' Conference Project		

Technology Transfer

The Innovations Transfer Project: Council for State Governments

The Innovations Transfer Project conducted by the Council for State Governments under a National Science Foundation grant represents a major effort at fostering the spread of innovation among state governments. The objective of the project is the identification, synthesis, and institutionalization of state-level innovation. The project is based on the premise that there have been a variety of innovations developed in recent years at the state level, but that the diffusion of these innovations has been retarded by the lack of a mechanism which would permit state officials to share information on project success and failures. In short, the ability of state officials to replicate successful innovations is constrained by their inability to validate the consequences of adopting an innovation, the lack of resources in innovative jurisdictions to package and share information, and the lack of a mechanism to promote the replication of successful innovations.

The Innovations Transfer Project began in 1975. By 1977 the project staff had reviewed a list of more than one hundred innovations. From this initial list, the project staff selected 22 innovations the first year, 30 the second year, and 30 the third year of operation to be reviewed by a state government advisory panel. Based on this review, a list of 28 projects was selected for in-depth study. Field research was conducted to provide greater detail about the development, operation, and institutionalization of each innovation and to provide formal validation of the research results.

The resulting "case histories" of specific innovations have been distributed via four channels: (1) a list of 370 officials assembled by the Council of State Governments who automatically receive all CSG publications, (2) a notice or flier which has been mailed to between 8,500 and 10,000 state officials inviting the recipients to request a copy of the report, (3) CSG advertisements in selected publications, (4) notice of the availability of the reports in CSG publications and at CSG meetings

Limited follow-up studies have been undertaken on selected projects such as health cost containment and technical services programs. A consistent finding of the follow-up studies has been that most innovations must be modified to a greater or lesser degree before they can be adopted in another jurisdiction. The modification process complicates the problem of ascertaining the origin of a transferred program and of identifying leader-follower patterns.

Most of the innovations evaluated by this project have related to management and information systems and to specific types of legislation. Among the innovations examined were (1) New York's revised procedures for administering state utility regulation, (2) Pennsylvania and New York's experiments in domestic agricultural marketing, (3) Florida's use of volunteers; and (4) California's demonstration project on health manpower licensing. To date, few of the 28 innovations selected for in-depth study correspond to hardware technology.

An Experimental Federal-State Technology Transfer Mechanism in Louisiana and Mississippi

This project, funded by the National Science Foundation, "explored the feasibility of a joint federal-state venture to adapt and apply federal research and technology at the state level." A Technology Applications Consortium, consisting of the Mississippi Office of Science and Technology, the Louisiana Technology Transfer Office, nonprofit organizations, universities, and NASA's National Space Technology Laboratories, attempted to match identified state needs with available federal technology service facilities The distinguishing characteristic of the Louisiana/Mississippi mechanism has been the formal institutional structure of the Consortium. The Consortium, which has been developed along network principles and which is based on a strong federal technology center (the National Space Technology Laboratories), is intended to increase technology transfer; it is not intended to replace any existing federal-state agency interaction.

The primary objectives of the project are (1) adaptation and application of federal technology to state uses, (2) provision of a significant user market for federal technology applications, (3) supply of factual evidence of the capabilities and limitations of the model being tested in this project, and (4) determination of the replication potential of this model to other political, regional, and institutional environments.

The Consortium operates at three levels: policy, management, and technical applications. A Joint Policy Council provides guidance to the Technical Assistance Office. The Council also attempts: (1) to integrate the activities and functions of the Technical Assistance Office with other federal and state applications efforts, (2) to define the state role in technology transfer, and (3) to develop alternative strategies for the continuation of the Technical Assistance Office.

The Management Board is authorized to implement the policies and directives of the Joint Policy Council. The Board is also responsible for contacting selected federal agencies, programs, and facilities and state agencies that have been identified as potential markets. The management board determines the responsibility, financial obligations, and authority of the many public and private parties involved in various projects, as well as the lines of communication among the parties.

The Technical Applications Staff stationed at the National Space Technology Laboratories is charged with identifying opportunities for better utilization of federal technology in state agencies and with developing an efficient mechanism for transferring appropriate technology. The staff also helps to identify state agency needs and to index existing knowledge, equipment, methodology, and services that are available from federal agencies.

S&T Information

National Governors' Conference· The Governors' Energy Project

The objectives of this project are to establish and test mechanisms which will assist states in establishing policies, strategies, and programs in the energy field. Project activities include. (1) development and implementation of an information retrieval and exchange program for state-sponsored research, (2) preparation of written critiques of proposed state studies, (3) development of state policies for data coordination and the design of economic models, and (4) assistance to states in reorganizing their energy management systems. In support of the above activities, studies have been undertaken in selected areas of energy conservation. In addition, the project staff nas (1) conducted regional briefings for new energy officials, (2) analyzed legislative constraints on the development of state energy policies and programs, (3) facilitated the development of federal/state policy in the energy area, (4) investigated the feasibility of regional centers to assist in resolving power plant siting issues, (5) assisted in the development of analytical tools to assess the impacts of continental shelf exploration, and (6) helped devise solutions to policy questions facing public service commissions.

National Governors' Association Policy Research Project

The National Governors' Association Project is an example of a science and technology information system that focuses on the informational needs of governors. During the first phase of the project, which

began in 1978, substantive areas will be identified in which the governors and their staffs perceive the need for policy research and a state/federal research agenda will be formulated. The second phase of the project will analyze specific decision-making techniques and policy-making processes that have been identified as important to state executives. The project will also identify, categorize, analyze and assess the utility of decision-making techniques that are currently used in state legislatures for possible application to the state executive branch.

Coalition of Northeastern Governors (Connecticut, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island)

The Coalition of Northeastern Governors (CONEG), formed in 1975, is an effort to develop a core of experts, ideas, and resources that can be tapped to address issues of interstate importance through regional mechanisms. The CONEG Policy Research Center was established in 1977 to provide the governors with ongoing staff analyses that fully and consistently reviewed regional concerns. Initial funding of the Center came from multiple sources: state contributions, private foundations, and federal agencies, such as the Economic Development Administration To date, staff efforts have been concentrated on four major groups of issues: energy problems and energy conservation, regional economic development, analysis of patterns of defense expenditures, and an examination of the impact of welfare reforms in the region.

Specific objectives of CONEG include the following: (1) identifying priority issues, (2) developing institutional links among member states for sharing and coordinating the use of S&T information

in solving regional problems, (3) developing relationships with other regional organizations for sharing S&T information related to regional development, (4) translating S&T research results and recommendations into viable policy options for gubernatorial action.

The rationale behind the regional approach developed by CONEG is that the governor's offices in the member states could not singly marshall sufficient resources to facilitate the development, preparation, and transmission of comprehensive reports delineating policy options for gubernatorial action. Specifically, CONEG experience during its first year of operation suggested that there was a need for a distinct center from which professional staff, working in cooperation with the seven governors' staffs, could direct the CONEG research program.

CONEG began to convene staff resources in 1977 by assisting in preparations for the Northeast Regional Studies Association meeting in Philadelphia The purpose of the Northeast Regional Studies Association is to render public service to the region through a coordinator and to exchange S&T information among private and state universities.

To date, CONEG has served mainly as a professional network performing an information transfer function. In the future CONEG's plans call for it to become involved in the innovation transfer function. Specifically, the Center will: (1) identify innovative programs with S&T elements which are relevant for regional sharing purposes and which are related to one of the governors' priority issue areas, (2) obtain full information from the innovating state on each innovation, and (3) synthesize the information and organize it for transmission to other states both within and outside the region.

Midwestern Governors' Conference Project

The objective of the Midwestern Governors' Conference project was to improve the use of available and appropriate S&T resources (i.e., universities, private sector, federal laboratories, etc.) in needs assessment and problem resolution. Specific objectives included the development of a preliminary list of issues perceived by the governors to be of "regional" significance, development of a list of researchable issues, and the commissioning of issue or option papers on high priority, regional economic growth and/or maintenance issues such as design efficiency, productivity, and capital formation.

Initially, 42 specific issues were identified by an ad hoc advisory group composed of governors' aides, appropriate science advisory groups, and representatives of the private sector. Brief papers were prepared for each issue, outlining the problem, identifying resource people, and suggesting alternatives for action. These papers were then reviewed by the Midwestern Governors' Conference Advisory Committee. Three issues have been selected for further study--(1) energy utility rates, (2) the problems of rail branch lines, and (3) state options for assisting family farms.

S&T Agent

The Center for Science Policy and Development (Hawaii)

In Hawaii, a science and technology center has been formally institutionalized within the state government. The Center, housed in

the Hawaii Department of Planning and Economic Development, uses the Governor's Science Advisor/Governor's Science Advisory Council apparatus as its mode of operation.

The Center is the recipient of a grant from the National Science Foundation to study science and technology policy options in the state of Hawaii. The project is oriented toward the decision-making process, specifically, the definition and analysis of institutional roles in the scientific decision-making process. Particular effort has been directed to the resolution of conflict between state objectives, agencies, and interest groups.

The technical staff of the Center draws upon the resources of the universities and private industry in Hawaii in support of its work. Both short and long-range projects have been undertaken. One of the specific activities of the Center, for example, has been coordination of the aquaculture programs operated by different state agencies in Hawaii and the development of the statewide aquaculture plan (which included preparation of economic studies and site surveys).

Michigan Executive Science Advisory Project

The principal objective of this phase of the project is the continued development, implementation and refinement of a mechanism for insuring input of S&T resources to the state policy management process. A second objective is to assess the potential for a more broadly-based Governor's Science Advisory Council. The Science Advisor, who also serves as the Executive Director of the Advisory Council, is partially institutionalized within state government in a position at the cabinet level of policymaking. The Science Advisor, until recently a senior

faculty member on released time from a state university, participates with other cabinet-level personnel in developing a framework for consideration of basic policy issues and in identifying new approaches for dealing with those issues.

The access to high level officials and current issues provided by the Science Advisor's partial institutionalization within state governments provides him with the opportunity to gain the cooperation of the central decision-making body of state government Moreover, the Science Advisor's maintenance of a formal relationship with the university system enables him to direct the resources of the universities to those aspects of research and policymaking which are likely to elicit the greatest return. The existence of a formal advisory council provides an opportunity for other council members to contribute their own resources and those of their supporting institutions to further the objectives of the project. In short, the program in Michigan potentially contains the best features of the science advisor/advisory council mode of operation as it has been developed in other states.

Footnotes

[1]Research and Development in State Government Agencies, Fiscal Years 1972 and 1973, National Science Foundation, Surveys of Science Resources Series, NSF 75-303, (Washington, D.C.. U.S. Government Printing Office, 1975).

[2]Irwin Feller, "State Budgeting for Research and Development," Proceedings of the Twenty-Seventh Annual Meeting of the National Association of State Budget Officers, 65-67.

[3]National Association of State Budget Officers, "Research, Technology and the Budget Process," Report to the National Science Foundation, Project No. ISR 7514280.

[4]Irwin Feller, Donald Menzel, and Alfred Engel, Diffusion of Technology in State Mission-Oriented Agencies (University Park, PA Center for the Study of Science Policy, 1974), 125-126.

[5]Merlin Hackbart and Janet Patton, Innovation in State Government Process (Lexington, KT University of Kentucky), Report to the National Science Foundation, Grant No. ISP 74-21905.

[6]Ibid , p. 22.

[7]Harvey Sapolsky, "Science Advice for State and Local Government," Science, Vol. 160, April 19, 1968.

[8]Jules Duga, Science and Technology in State Government Policymaking: Past, Present and Potentials, Report to the National Science Foundation, Grant No. GT-44225.

[9]Wesley Long and Irwin Feller, "State Support of R&D: An Uncertain Path to Economic Growth," Land Economics, 48.3 (August 1972), 220-227.

Section V

State Legislatures

Introduction

Federal programs to transfer technology and scientific and technological information to state governments must be based upon an awareness and understanding of the resurgent role of the legislative branch of state government. Two dissimilar sources, U S. News and World Report and the Council of State Governments, have described this resurgence as follows:

> Once ridiculed as a 'do nothing' and 'sometimes governments,' state legislatures are quietly being transformed to the point of upstaging Congress in tackling tough issues of the day.[1]
>
> * * *
>
> The development of legislative strength and independence and the improvement of state legislatures evident during the past 20 years continued in 1976-77. A major aspect of current legislative development is the heightened interest and capability for reviewing and analyzing the activities of government and overseeing the performance of the executive branch in program administration
>
> ...(the) development of legislative independence and equality with the executive branch has greatly contributed to the growth of legislative oversight activities. . (The) realization by state legislatures of their need to influence state-federal relationships and the programs and policies of Congress and the national administration has led to increased legislative scrutiny of the operation and impact of federal programs within the states. In particular, the effect of federal grants on state programs and priorities has become the subject of legislative attention [2]

The involvement of state legislatures in activities and issues relating to the utilization of S&T knowledge, particularly as these

relate to federal programs, is of relatively recent origin. State legislatures, for example, were rarely included in the set of "relevant" actors in many of the initial efforts in the early 1960s to improve linkages between state and local governments and the scientific and technical communities. The entry of this branch of state government into the intergovernmental science arena has been seen on occasion as more of an intrusion in federal-state relationships than as a necessary or desirable expansion in the definition of the relevant user communities. However, whatever the degree of warmth with which they have been included in the ambit of federal-state S&T knowledge utilization programs, there is little question that state legislatures have asserted the right to be involved in such programs. Moreover there is a growing, if not necessarily widespread, recognition on the part of federal agencies that the effectiveness of their state-oriented programs must take the legislative branch into account.

State legislatures have emerged as direct users of federal S&T knowledge transfer programs. Few developments have been as significant among the changes occurring in state legislatures as the increased scientific and technical complexity of issues which legislatures must treat and the recognition by many legislators that new and different types of information (and information sources) are needed within the legislative setting to make more informed decisions on these issues. In this respect, the increased independence and assertiveness of state legislatures have led legislators to be more conscious of the quality of their own decision-making capabilities and thus more receptive to "technical" as distinct from "political" information.

Several general observations are in order before considering the characteristics and outcomes of federal S&T programs directed at state legislatures. As indicated in Table II-1, the principal stake of state legislatures in the technology-transfer R&D utilization system is in access to scientific and technical information. With the possible exception of computerized information and management systems, legislatures themselves are not the end users or intended targets of technology transfer programs. Their involvement in technology transfer activities occurs primarily through their powers of appropriation, specifically in those instances when they are called upon to appropriate matching funds or to support technology transfer projects initiated between a federal agency and a state mission agency. (It should be noted that although technology transfer in a narrow sense is a secondary consideration of the involvement of state legislatures in scientific and technical questions, it is their ability to influence the life of project activities at the agency levels which has made it increasingly necessary for federal agencies to involve legislatures in such projects. In this report, the endeavors by federal agencies to involve legislators in the activities surrounding a technology transfer project represent an effort on the part of these agencies to build a "coalition" within the user community which will support the project after the federal program has expired.)

Analysis of the extent to which state legislatures have to treat scientific and technologically complex issues has led to three major findings. First, the percentage of bills introduced into a state legislature which contain a discernible scientific and technical component was estimated as being in the 17-20 percent range in the first study

undertaken on this topic in 1972.[3] More recent estimates generated as part of the efforts in several state legislatures under the State Science Engineering and Technology Program have clustered about this range. Although these estimates tend to be judgmental, often reflecting the definition of what constitutes science and technology employed by the research team, they do serve to indicate the number, share, and range of S&T-related issues and, thus, the potential demand within a legislature for improved access to scientific and technical information.

Second, a substantial portion of the scientific and technically complex agendas which state legislatures must now confront has been created by the passage of federal legislation which has required the states to enact implementating legislation. Table V-1, contains a list prepared by the National Conference of State Legislatures of examples of such legislation.

Third, state legislatures are concerned with policy issues--energy, environment, health--not with science and technology issues as such. Concepts such as technology transfer, research utilization, R&D agendas, and the issues surrounding the design of programs related to these concepts which are the lingua franca of federal agencies and the scientific and technology communities have little currency within the state legislative agenda. This perspective has most succinctly been stated in the title of a paper by Rosenthal, "Energy-Schmenergy: The Problem is Putting Information to Work."[4] This perspective has been analyzed more formally by Feller and his colleagues in a study of the processes by which state legislators search for scientific and technical information.

TABLE V-1

Federal Laws Delegating
Implementation Responsibilities to the States

Federal Coal Mine Safety Act Amendments of 1965

National Traffic and Motor Vehicle Safety Act of 1966

Highway Safety Act of 1966

Federal Metal and Nonmetallic Mine Safety Act

Natural Gas Pipeline Safety Act of 1968

Radiation Control for Health and Safety Act of 1969

Federal Railroad Safety Act of 1970

Occupational Safety and Health Act of 1970

Energy Policy and Conservation Act (EPCA)

Energy Conservation and Production Act (ECPA)

Coastal Zone Management Act of 1972

Resource Conservation and Recovery Act

National Mass Transportation Assistance Act

Omnibus Crime Control and Safe Streets Act of 1968

Lead Based Paint Poisoning Prevention Amendments

Clean Air Act Amendments of 1970

Federal Environment Pesticide Control Act of 1972

Noise Control Act of 1972

Federal Water Pollution Control Act Amendments of 1972

Marine Mammal Protection Act of 1972

Safe Drinking Water Act of 1974

Marine Protection Research and Sanctuaries Act of 1972

Emergency Highway Energy Conservation Act

Title XIX of Social Security Act (Medicaid)

National Health Planning and Resources Development Act

Health Maintenance Organization Act of 1973

Emergency Medical Service System Act of 1973

Juvenile Justice and Delinquency Prevention Act of 1974

Source: National Conference of State Legislatures.

> It is clear that the state legislative agenda is not directly attuned to scientific and technological outlooks... (There is) substantial dissatisfaction with the current quality of substantive information concerning issues. Legislators simply want to know more about how proposed legislation on a wide variety of issues will actually affect their states; they see a need for information of all kinds, not just the S&T variety....
>
> Legislators not only want more information; they want more "objective information..."
>
> To the extent that law makers have scientific or technological information in mind...many expressed a profoundly ambivalent position. They desire access to scientific or technological expertise, but unfortunately, in their eyes, it must ultimately come from experts. Although they seek information, many legislators expressed considerable doubt that the "experts" are truly objective.... (Legislators) are wary of the introduction of normative judgments into an incomprehensive (to them) presentation of the technical complexities of controversial issues. Many believe that when the expert testimony is completed, they will be no better off than before if the experts are trying to give them unequivocally "correct" answers. The lawmakers must still take public stands in an environment of contending positions.[5]

Taken together, the import of these findings, for purposes of this study, is that although state legislatures have come to recognize their need for types of information which extend beyond their traditional lines of activity, they have reservations concerning both the "neutrality" of information provided by the federal government, which in several areas is seen as the cause of their having to legislate on controversial topics, and the "objectivity" of the scientific and technical communities to whom they have and are being encouraged to turn and to trust for the information they require

Finally, permeating any discussion of an assessment of what federal strategies have worked or are likely to work for state legislatures, must be the recognition of the great variations that exist among the states in the institutional environments within which the legislatures operate. These differences are so obvious that there is

a real danger in taking them for granted. The range between the "part-time citizen" and the "full-time, professional career legislator" is enormous. The differences between the biennial compensation received by legislators in New Hampshire and Rhode Island, $200 and $600 respectively, and legislators in California and New York, $60,569 and $47,000, symbolize the disparities which exist in all aspects of legislative performance. Perhaps the single most important difference for this study is the difference in the staff support system. The range is from a small number of individuals, usually comprising a central research staff whose primary function is bill drafting and budget preparation and whose training tends to be in the fields of law, public administration, and accounting, to full-time committee staffs for both the majority and minority parties, augmented by large centralized staffs consisting of specialists in several disciplinary or functional areas.

In seeking to either directly relate to state legislatures or to provide assistance to them through the support of intermediaries, federal agencies are thus confronted with an institutional environment in which some of the potential users may lack the most rudimentary capability to benefit from the federal program (e.g., successfully complete an application to receive a federal entitlement grant, absorb the contents of a "tech brief"), while other users regard themselves as possessing a staff at least as technically competent as that of the federal agency or as having their own close ties with scientific and technical communities that may be different from those which the federal agency is seeking to promote.

Funding Techniques

Federal grants have been a widely used technique either to foster specific activities on the part of state and local governments or to improve their general governmental capabilities. Until relatively recently, however, this instrument has not been used to assist state legislatures. Three principal issues affected their use First, there were some questions as to whether state legislatures were eligible recipients of federal grants This interpretation tended to treat the executive branch of state governments as equivalent to all of state government, ignoring the independent constitutional roles assigned to legislatures. The matter of grant eligibility was seemingly addressed and resolved in a 1969 "Memorandum to Heads of Executive Agencies" issued by the then Bureau of the Budget. This memorandum stated that. (a) state legislatures and state legislative agencies were eligible to apply for federal grants-in-aid unless a federal statute specifically excluded their eligibility, and (b) applications from state legislatures or legislative agencies were to be considered on their merits, as against other competing applications, in the making of awards. Second, the omission of state legislatures was mainly another consequence of the vertical relationships which had come to dominate intergovernmental relations. Mission agencies in the federal government tended to relate to their functional counterparts in state governments. Thus, federal agencies responsible for transportation, housing, environmental protection could be expected to channel grant-in-aid funds made available by federal legislation to their counterpart agencies in state government, with little attention paid to the needs or claims of state legislators for a technical competency which was to some degree comparable

to that supported in the mission agencies. Third, although state legislatures may have been nominally eligible for federal grants, they often lacked the requisites of grantsmanship to obtain them. State legislatures were not informed (or did not seek) information about the availability of federal funds. Furthermore, they often were not able to resolve the internal management question of who the applicant would be. They frequently lacked the staff resources and expertise to prepare proposals which would meet panel review criteria, especially if funds were to be awarded on a competitive basis. In general, they themselves did not aggressively assert their claims of eligibility. Finally, with specific regard to technology transfer, state legislatures have not been found to be directly involved in the selection of technologies by mission agencies

Both the situation with respect to federal grants to state legislatures and the specification of grants related to the federal program objective of fostering the use of technology has changed. State legislatures are clearly eligible to receive federal grants-in aid According to a 1976 survey conducted by the National Conference of State Legislatures, 17 state legislatures received 38 grants from federal agencies in the period of 1971-1974. The principal source of these grants was the Law Enforcement Assistance Administration, which awarded 19 grants to ten legislatures, mainly for criminal code revision. A more recent but not directly comparable survey conducted in 1977 by the New York State Assembly Ways and Means Committee indicated that 17 state legislatures received direct grants in the period 1959-1977 (Table V-2), while an overlapping set of 13 legislatures received indirect grants-in-aid (Table V-3).

TABLE V-2

DIRECT FEDERAL GRANTS-IN-AID RECEIVED BY STATE LEGISLATURES

GRANT APPLICANT	TOPIC	AMOUNT	FEDERAL AGENCY	DATE
ARIZONA				
Legislative Council	Human Resources	225 000	HEW	–
CALIFORNIA				
Assembly Rules Committee	Development of Combustion Steam Engines for Busses	499,448	Dept of Trans	1969
Assembly Rules Committee	Maintenance of Steam Engines and Demonstration of Improved Technology	633 041	Dept of Trans	Continued
State Assembly	State and Local Inter Govt Science Policy Program	73,000	NSF	1970-73
	Analysis of California s Job Agent System	106 500	Dept of Labor Manpower Admin	1970
State Assembly Legislature	Planning Grant for Sabbatical Program	5 000	NSF	1975
	HUD Program Goals	180 000	HUD	Between 1974-77
	Energy Supply & Forecasts	65 000	Fed Energy Administration	Between 1974-77
	Development of Energy Legislation	40,000	Fed Energy Administration	Between 1974-77
	Information Interchange between State & Business	5,000	NSF	Between 1974 77
ILLINOIS				
Legislative Council	Defray Costs of Science Advisor's Salary While on Loan from NSF	14,667	NSF	–
	Training	2,000	Civil Service	1974
KANSAS				
Legislative Council	Public Health Resource Study	27,000	HEW	1967
KENTUCKY				
Legislative Research Commission	Environmental & Economic Development Policy	25,200	NSF	1973
LOUISIANA				
Joint Legislative Committee on Environmental Quality	Development of Environmental Management Systems	271 222	EPA	–
Joint Legislative Committee on Environmental Quality	Regional Land & Water Management Programs		U S Army Corps of Engineers	1974
MASSACHUSETTS	Developing Science & Technology	117,000	NSF	1975
MINNESOTA	Science & Technology	41,500	NSF	1977
MONTANA				
Legislative Council	Legislative Improvement	30,000	HUD	1971
NEBRASKA				
Legislative Council	Office of Public Council (Ombudsman)	65 047	EDA	–
	Revision of State s Statutes to Eliminate Discrimination	3,000	IPA	1976 77
NEW YORK				
State Senate	Energy Legislation in the Northeast	33,700	NSF	1974
Assembly Speaker	Scientific Staff Support	124,200	NSF	1972
State Senate	Regional Energy Staffing Problems	69 600	NSF	1975
State Senate	Regional Energy Staffing Problems	10 000	Federal Power Commission	1975
State Senate	Balanced Growth Conference	42,000	EDA, EPA	1975
NORTH DAKOTA				
Legislative Council	Regional Environmental Assessment Program	15 000	EPA	1975-77
	Regional Environmental Assessment Program	60 785	EDA	1975-77
	Fort Union Coal Conference	153,800	NSF	1975
OKLAHOMA				
Legislative Council	Rehabilitation for Disabled	17 836	HEW	1959
	Emphasis on Mentally Ill	32 458	HEW	1961 63
	Research on Legislative & Admin Alternatives	14 000	HUD	1976 77
	Appropriation of Federal Funds by State Legislatures	3,337	HUD	1977
OREGON				
Advisory Committee State Land Board	Riparian Rights	20 000	Dept of Interior	–
Joint Interim Committee on the Judiciary	State Highway Safety	69,100	Dept of Trans	–
	Study of the Financing of Elementary & Secondary Education	183 886	U S Office of Education	1974 On
PENNSYLVANIA	Use of Resources of Six State Supported Universities	78,000	NSF	1976
SOUTH CAROLINA	Science Intern	10,000	NSF	1977
WISCONSIN	Science Intern Program	22,000	NSF	1975

Source: "Federal Grants to State Legislatures," New York State Assembly, The Ways and Means Report, July-August 1977, 4.

TABLE V-3

INDIRECT FEDERAL GRANTS-IN-AID RECEIVED BY STATE LEGISLATURES

STATES	TOPIC	AMOUNT	FEDERAL AGENCY	RESULT	DATE
ALABAMA	Technical Assistance Prog	248 210 36	NSF	Granted to Auburn University	1973 77
ARIZONA	Criminal Law Revision	381,000	LEAA	Grant may have been passed through a state agency*	1972-75
IDAHO	Criminal Law	8,750	LEAA	Funded to State Agency	1970
ILLINOIS	Study Plan for the Aged	39 900	HEW	$10,000 funded through Intergovernmental Cooperation Commissioner, remainder by State Agency	1970
	Local Zoning Problems	7,400	HUD (701)	Funded as part of Illinois State Planning Agency Work Program	–
	Science Intern	7,200	NSF	Funded to Sangamon University	1974
KANSAS	Public Health	94,527	HUD	Funded to Economic Development	1967
	Education Master	25,013	HEW	Funded to State Education Committee	1971
	Education Planning	107 642	HEW	1975-1977 Grants given to Kansas Legislative Education Planning Committee (designated by the governor as 1202 Post-secondary Education Planning Commission)	1975-77
	Review of School District Equalization Act	15,000	NIE through NCSL	Grant given to Kansas Legislative Education Planning Committee	1978
MINNESOTA	Comprehensive Review of Vocational Rehabilitation	40,000	HEW	Funded to Education Division of Vocational Rehabilitation	
	Planning Assistance Programs for Urban Indians	35,000	HUD	Funded to State Planning	
	Vocational Education	10,000	HEW	Funded to State Department of Education	
NORTH DAKOTA	Study of Criminal Justice	32,000	LEAA	Legislative Council*	1975-76
	Study of Corrections & Penology Systems	49,896	LEAA	Legislative Council*	1977-79
OKLAHOMA	Planning Analysis & Development of a State Management Structure for Planning	34,000	HUD	Awarded to Office of Research & Public Service – University of Oklahoma	
	Revision and Codification of Planning Laws	20,000	HUD	Funded to Industrial Development & Park Dept	1969
PENNSYLVANIA	Research & Technology	100,000	NSF	Funded through Penn State U	1973-75
SOUTH DAKOTA	Study done by National Committee on Uniform Laws & Ordinances	Amount Not Available	U S Dept of Trans	Funded through South Dakota Dept of Highways	1968
TENNESSEE	State Capitol & Legislative Facilities Security	750	LEAA	Legislative Council*	
	School Finance Study	34,500	NCSL	Legislative Council	1974
TEXAS	Judicial Reorganization & Reform	130 000	LEAA	House Judiciary Committee*	1971-74
UTAH	Legislative Goals Program 701	2,000	HUD	Funded to State Development Program	1967

* LEAA funds go to the state planning agency according to federal regulations Legislatures may request funds directly from this agency This is distinct from grants in aid directly from the federal government to state legislatures Here a federal statute prohibits funding directly to state legislatures

Source: "Federal Grants to State Legislatures," op. cit.

A major source of the increase in the number of direct grants made to state legislatures was the development of a State Legislative Program element in the National Science Foundation's Intergovernmental Program. The NSF program was the first to directly view state legislatures as a target population. It remains the major federal program addressed to the special issue of strengthening state legislative capabilities in the area of science and technology.

The most important element in the (re)assertion of state legislative powers is in the area of legislative participation in the expenditure of federal grants to the states. This constitutional question between the executive and legislative branches at the state level is now before the courts. The landmark decision to date is the 1976 Pennsylvania Shapp versus Sloan case, which upheld the right of the Pennsylvania Legislature to appropriate all monies deposited in the state treasury. This decision was upheld in 1978 by the Pennsylvania Supreme Court. Pennsylvania's Governor, Milton Shapp, announced plans to challenge these decisions in the federal courts, so the matter of state legislative control of federal funds is still unresolved. Other state legislatures are also considering methods for acquiring control of the disposition within their borders of federal grants. In Oregon, for example, the legislature reviews state agency applications for federal grants before these grants are submitted. If the application is rejected, it cannot be submitted to the relevant federal agency.

In general, two major issues seem to underlie the power of a state legislature to control the dispensation of federal grants. First, there is the constitutional question within each state as to the power of the legislature. In some states, state courts have held that

legislative prerogatives do not extend to the authorization of federal funds (Colorado), while in others the specific form of legislative control (e.g., Montana--delegation to a committee during legislative interims) has been declared unconstitutional. Second, there is the potential constitutional question at the national level which is likely to be raised if and when the Shapp case reaches the federal courts. Federal grants to states total about $73 billion and account for as much as one-quarter of many state budgets. It is estimated that about 75 percent of total federal grants are channeled directly from a federal agency to a state mission agency where they are used either to finance state-level programs or to pass through to local governments State legislatures have increasingly asserted their right to authorize expenditures of these funds on the grounds (a) that state activities should reflect the preferences of the elected representatives of the states, (b) that federal funds have been used to support state agency activities which were specifically denied by the legislature, and (c) more pragmatically, from concern that federal funds have frequently been employed to build constituencies who press for continuation of programs after federal seed money has run out. From the perspective of state legislatures, the injection of federal funds may, over time, serve to torque state priorities in a manner which may be inconsistent with the preferences of the legislatures (or the electorate).[6]

Finally, the State Science Engineering Technology program represents another advance in the legislature's assertion of its need for and eligibility for federal grants-in-aid. Among the administrative features of the SSET was the provision of a pool of funds which state legislatures could apply for separately from the pool made available

to state executives. Although the future level of support for this program is as yet not clear, it does seem likely that separate funding channels for the executive and legislative branches will probably be maintained if the program continues.

Beyond grants made by single agencies to single legislatures, a consortium of federal agencies has emerged which has funded collaborative efforts at reaching a number of state legislatures The most important example of this type of arrangement for the present study is MISTIC, which at present is funded by federal agencies through a series of interagency agreements with the National Science Foundation.

Direct federal grants to state legislatures have become an acceptable, if not widely used, technique. Grants have been made to state legislatures for a variety of planning and action programs, including several specifically related to technology transfer. The limited number of applications emanating from the state legislatures in part reflects the lack of: (1) a familiarity within these bodies with federal grant procedures, including information concerning the availability of funds, (2) personnel available to prepare applications and proposals, and (3) management and financial procedures which accord with federal requirements It also appears, in part, to reflect a desire to pursue state-initiated solutions without having to become enmeshed in federal requirements.

The emergence of state legislatures as eligible and increasingly sophisticated and adept claimants for federal grants has not been total, nor has it as yet fully intruded on the set of intergovernmental issues relating to technology transfer On the first point, only 22 state legislatures applied for direct federal grants in the

period of 1975-77. The small number of applicants (compared, for example, with the 42 legislatures which applied for the SSET program alone) to a large part reflects the uncertainty that still exists within state legislatures as to their eligibility for federal grants. As expressed by one respondent to the New York State Assembly survey, who believed his state was ineligible for federal funds, "We have always been under the impression that only the Governor's Office, administrative agencies, and private organizations were eligible for research or action grants." A 1978 survey suggested that, "the notion of federal grants to state legislatures remains, to many, a foreign idea."[7]

Additional issues concerning legislative applications for federal funds appear to have arisen as a result of the A-95 OMB review process As part of the review process established under A-95, a state clearinghouse is organized to review applications for federal funds made by state agencies. From the legislative perspective, this procedure creates an imbalance in the relative influence of the two branches in securing federal funds A state legislature's application for federal grants goes through the state's A-95 review process and thus may be subject to the scrutiny of the state's executive branch. No comparable state legislative review occurs for applications initiated at the state's executive level. Moreover, although the A-95 process does not provide for rejection of an application at the state level, there is the possibility, or at least an expressed concern at the state legislative level, that state executive opposition to legislative proposals will cause the latter to be given low priorities in federal funding programs

Technology Transfer

The role of the legislatures in the utilization of science and technology, regardless of whether the proposal emerges from a state mission agency or is transferred from a federal agency, begins with the appropriations process. At some point in the transfer, adoption, implementation cycle, state legislatures will be called upon to appropriate funds This appropriation may be to directly support technology utilization programs, to provide cost-sharing contributions on federal grants, or to accept implementation costs after the expiration of a federal demonstration project. The combination of the financial stringencies of most states, the increased assertiveness of state legislatures in reviewing executive budget requests and agency activities, and the improvement in their internal staff capabilities which permit them to assert their expertise on technical matters, has resulted in a more active role in an area in which line agencies were largely autonomous actors.

This changed status of legislatures requires a rethinking on the part of federal agencies seeking to foster the use by state agencies of technologies developed under federal sponsorship. The sequence of events generated by a vertical system of intergovernmental relations, such that when a state mission agency accepts the advice and/or preferred technology of a federal agency it need concern itself with a formal but nominal review by the legislative branch, is likely soon to be referred to as "the good old days." One likely reaction to

this change is lamentation, a decrying of the intrusion and obstructionism of a technically nonqualified legislative branch into the processes of technology transfer. Whatever merits such laments might have, they themselves will do little to restart an aborted technology transfer process because the underlying impetus for the legislative scrutiny relates not to technology transfer issues alone but to the full range of state activities.

Information Systems

State legislatures are in the process of developing two types of information systems: (1) a national, general information clearinghouse, MISTIC, and (2) a number of specialized, regionally-based systems, such as the Northeastern Regional Legislative Staff project which focuses on energy issues

The Model Interstate Scientific and Technical Information Clearinghouse (MISTIC) is an example of a federally supported technical information clearinghouse for state legislatures which is operated by an intermediary, the National Conference of State Legislatures More so than any single federal agency's information dissemination program or the National Technical Information System, MISTIC is regarded by the users, state legislatures, as an organization of their own.

During 1978, MISTIC received financial support from five federal agencies--Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, National Bureau of Standards, and the National Oceanic and Atmospheric Administration. Administrative support for MISTIC was provided by the National Science Foundation.

MISTIC represents an important comingling of federal agency objectives to promote the utilization of scientific and technical information related to their mission activities with the development of a broad-based institutional capacity on the part of state legislatures to reach out to scientific and technical resources external to the legislatures but extending beyond the federal agencies

Procedurally, MISTIC receives requests from state legislatures for information on specific technical matters then before the legislature. The MISTIC staff then seeks assistance from those federal agencies with whom it has formal ties as well as from other sources of information which it may have identified in universities, private industry, professional societies, and other states.

A summary of the information received is then provided to the legislature which initiated the request. "Tech briefs" are prepared for general distribution on those issues which have widespread currency in a given year in state legislatures (A list of the topics covered in requests to MISTIC for one month, March 1978, is presented in Table V-4.) In addition, MISTIC prepares a monthly newsletter, "Science and Technology for the Legislatures," which reports on state legislative issues and reviews selected reports from state and federal governments.

MISTIC serves as a readily identifiable contact point for state legislatures and their staffs Its work is oriented to summarizing and organizing technical issues in a manner which is consistent with the information retrieval and information use patterns most prevalent in state legislatures. From the federal perspective, MISTIC serves two other roles. First, it provides a ready entry point for the

TABLE V-4

March 1978 MISTIC Information Requests

Information about Chiropractic training and practice

Requests (4) for. "Technical, Environmental and Economic Aspects of Highway Deicing Salts"

Request for copies of Iowa, Minnesota and Nebraska gasohol bills and California, Minnesota and Utah waste oil recycling laws

Information about state beverage container laws

Information about gasohol, deicing salts, legislative foresight, and state and city auto emission programs

Request for copy of Washington and Oregon "good samaritan" laws

Request for copies of Minnesota, California and Utah waste oil recycling laws

Background information about Recombinant DNA and state legislation

Information on model toxic chemical regulation legislation

Information on the health effects of air pollution

Information about groundwater contamination

Information about the effects of studded snow tires and other state restrictions

Request for background information on several subjects (previous MISTIC information requests)

Request for copy of: "Gasoline/Alcohol Blends: A Possible Fuel Resource for Minnesota," Minnesota House of Representatives Research Department, September, 1977

Background information about the economic and environmental effects of deicing salts

Information on medical records privacy legislation, physician assistants licensing and legislature-university links

Request for copies of California, Minnesota and Utah waste oil recycling laws

Expert contact for background information on liquified natural gas

Information about the technical and economic feasibility of gasohol and copies of gasohol legislation recently introduced in Congress

TABLE V-4 (Continued)

Request for copy of: "Other States' Industrial Waste Disposal Practices", Illinois Legislative Council, December 15, 1977
Information about other states' activities in regard to home health agencies
What percentage do soft drink containers represent of the total beverage container market and request for a copy of California's beverage container law (SB 560)

Source: National Conference of State Legislature

distribution of technical information generated as a result of an agency's operations, and thus overcomes the historic absence of close linkages between federal agencies and state legislatures. Studies of legislative information-use patterns show that state legislatures regard federal agencies to be among the least accessible and least useful sources of information. Second, the "network" or clearinghouse concept in which many users communicate to many different suppliers through a single intermediary organization has intrinsically appealing features of cost-effectiveness. The potential savings in the "costs" of searching for information are reinforced both by the likelihood that the policy agendas of different states will resemble each other fairly closely within a short period of time and by the strong inclination in state legislatures when coping with complex problems to seek information not only on the technical aspects of a problem but also on how other state legislatures have handled the problem.

State legislatures are also experimenting with the development of a nationwide computerized information retrieval system for "policy research" reports. The proposed system, the Legislative Information System (LIS), is being developed under a grant from the National Science Foundation to the National Conference of State Legislatures. LIS would supplement the computerized information systems now in use in many state legislatures for bill drafting, reporting and statutory retrieval. As operated in its early stages, LIS collects research reports from state legislative service agencies in Colorado, Connecticut, Illinois, Iowa, Oklahoma, Washington, and Iowa. The system is projected to be fully operational by 1979. The rationale behind LIS is that the

policy issues and focus of policy research are likely to be similar across a wide variety of states.[8] The degree to which this is true and to which LIS can provide varieties in individual approaches to each querying legislature will be the measure of its lasting success.

S&T Agent

The S&T agent approach in state legislatures is more appropriately and more simply defined as a staff approach. Of the various approaches considered, the addition of a staff person or an S&T unit within the legislature is not only the approach most favored by legislators but also the one which has proven most viable over time of the various approaches attempted (e g., S&T advisory council, university-based clearinghouse). S&T staff fulfill a legislature's need for a broker who can adapt information supplied by the external S&T communities to a format which is readily-accessible, and presumably more comprehensible by them Staff personnel are more readily available and are more accountable to the legislature than are external resources. Staff can be relied upon more than other sources to synthesize and summarize information in a manner which meets legislator's needs, and, also, if necessary, to cast the information in a manner tailored to the context of the legislative debate. Staff can be asked to verify the professional credentials of outside experts or to identify their known positions on an issue, and to arrange panels or hearings between legislators and these communities.

S&T staff are not, however, an unmixed blessing. Although it has been customary in analyses of the shortcomings of the performance of state legislatures to note the paucity of staff to assist legislators and to treat staff augmentation as inherently beneficial, there have also been cautionary comments sounded by legislators themselves as to their growing dependency on such staff.[9]

The augmentation of legislative staff capabilities through the employment of S&T agents has been the single most important aspect of legislative involvement in the S&T field during the past decade. Whereas 10 years ago it would have been difficult to identify any specialized unit within any state legislature specifically charged with staff responsibility for scientific and technical issues or individuals employed in state legislatures with advanced degrees in the physical or biological sciences, such units and individuals today exist in several states. This development is consistent with other studies of legislative preferences for coping with the increased technical complexity of the policy agenda, which have strongly pointed to preferences for staff in those cases where none exist Indeed, the employment of staff personnel is consistent with almost all studies of legislative behavior which indicate that legislators turn to their staffs as either the first or second most important source of information, whereas external sources of information (e.g., professional associations, federal agencies, universities) rank relatively low on any list of possible information sources

A compendium of recent staff projects, compiled by the National Conference of State Legislatures, is listed in Table V-5. Before examining a few of the major projects, however, some of their general

TABLE V-5

Science and Technology-Related Resources
in State Legislatures

State/Location in Legislature	Name/Resource Mechanism	Brief Description
Alabama	Legislative Technical Assistance Program	Created July 1974, with funds from NSF Experimental R&D Incentives Office, brokerage mechanism concentrating on utilizing state universities as technical resource
Arizona/Senate/House	Human Resources Services Staffing	Program initiated with HEW funds to strengthen Legislature's capacity in human resources areas has resulted in specialized staff for legislative committee HEW funding ended FY 76
California/Assembly	Assembly Science and Technology Advisory Council	Initially created 1970, partially funded by ISRU office of NSF, and expert advisory panel, functions semivolunteer fashion through a resident staff in the Assembly, fully supported by the Assembly
	California Public Policy Seminars	Involves a panel which includes leadership from both houses, the Governor, and President, and senior faculty of the University of California Panel selects long-term policy research projects to be undertaken by U C faculty Entirely funded by the University
Georgia	Division of Legislative Research Institute of Government University of Georgia	Initiated in 1977 through a one-year grant from NSF/ISPT. Funding allows for 1 full-time professional, part-time clerical help, a graduate assistant, plus some consulting The intention of the program is for institutionalization in one to two years
Hawaii/Senate/House	Legislative Scientific Advisory Committee	Expenses paid, no salary, advisory panel under administrative jurisdiction of office of the Legislative Auditor, established 1972, in operation 1974
Illinois/Legislative Council	Science Research Unit within Legislative Council	A centralized professional staff mechanism within Legislative Council, fully funded by Legislature.

Table V-5 Continued

State/Location in Legislature	Name/Resource Mechanism	Brief Description
Kentucky/Legislative Research Commission	Special project within the Legislative Research Commission	Jointly funded by State and NSF to plan for environment/energy policy Resulted in a Governor's Energy Advisor
Maryland/Dept of Legislative Reference	Science and Technology Advisor	Established May 1977 to staff the Select Committee on Energy, assist Legislative Reference staff and individual legislators with technical inquiries, and coordinate with the Maryland Academy of Sciences and the Governor's Scientific Advisory Council
Massachusetts/Senate/ House	Science Resource Network	Initiated 1975 with NSF funding, professional staff established under auspices of leadership of both houses, with direction provided by Science Resource Committee. Last NSF renewal recently applied for (Nov 1977)
Minnesota/Legislative	Minnesota Science and Technology	Established in 1975, partially funded by NSF Staff of two professionals and two interns are overseen by the Legislative Coordinating Council and its Science & Technology Committee.
New York/Assembly	New York Assembly Scientific Staff	Created 1971, partial funding from ISRU-NSF, professional bipartisan staff, within speaker's office Now fully supported by the N Y. Assembly.
Ohio/Legislative Service	Principal Research Associate, Science and Technology	Initiated January 1977 Reports to Director of Legislative Service Commission Totally supported by the Legislature
Pennsylvania/House	Legislative Office for Research Liaison	Links 6 state university S&T resources to legislative needs Policy set by the Legislative Committee for Research Liaison Partial funding from NSF/ISPT
South Carolina/Legislative Science Commission	Graduate Science Intern Program	Initiated 1977 one year under grant from NSF/ISPT, with partial support from the legislature University of South Carolina and Clemson University participate
Utah/Executive/Legislative	Utah State Science Advisory Office	A central science advisory mechanism with executive director, state funded

Table V-5 Continued

State/Location in Legislature	Name/Resource Mechanism	Brief Description
West Virginia/Executive/ Legislative	Science & Technology Advisor (Dean of Engineering at West Virginia University)	Initiated 1975. Science Advisor provides S&T advice on consulting basis Expenses paid, no salary
Wisconsin/Legislative Council	Science & Technology Program	Science staff within the Legislative Council, a staff scientist, science analyst, and an intern provide support to standing committees, Council staff, and individual legislators

Source. National Conference of State Legislatures, "Science and Technology in State Legislatures" (Denver, Colorado NCSL, 1978)

characteristics should be noted. (1) Most S&T projects have received their initial funding through project grants from the Intergovernmental Program of the National Science Foundation. (2) Some of the earliest of these projects, e.g., California, New York, Illinois, have been successfully institutionalized in the sense that total or predominant financial support for the agent is now provided by the state legislature. (3) For the most part, the personnel employed in these positions possess advanced degrees, including doctorates, in the physical sciences. This pattern indicates that state legislatures can secure the services of technically trained personnel, provided, of course, that salaries are competitive with other employment alternatives. Informal contacts with these individuals also indicate that all have an appreciation of the political aspects of their work and of the need to provide ready or rough approximations of answers to technical problems rather than to push for the "precise answer" which might be required in more research-oriented or academic environments. (4) The placement of these agents within the organization framework of the legislature has varied. In New York, for example, the project started as a separate science and technology project located in the Speaker's Office in the Assembly. In Illinois, the project began as a personnel exchange between the National Science Foundation and the Illinois Office of Legislative Research. In Wisconsin, a similar pattern of adding the science and technology staff to the legislative office of research was followed. (5) For the most part, S&T projects have been undertaken in those states (e.g., New York, California), which have legislatures which meet on an annual basis and which have other attributes (e.g., legislative salaries, existing staff) that characterize a "professional" legislature. This characteristic is in keeping

with the observation noted earlier that the use of legislative funds for specialized staff personnel would be likely to occur only after more general legislative needs for information were met. (6) The use of a legislative staff model is also significant because of what it implies about the lack of appeal of alternative mechanisms within the legislative arena. For example, California had experience with a legislative science advisory committee (Assembly Science and Technology Advisory Council) prior to the employment of a legislative staff scientist. This advisory council was not found to be particularly useful in the legislative decision-making arena. The Council was comprised of leading academic scientists and representatives from professional associations. It channeled its work at assessments of long-term state needs rather than at specific and immediate issues on the legislative agenda. Moreover, the Council was unwilling to participate in political activities that were sometimes necessary to convert research findings and reports into specific pieces of legislation. In general, although Maryland is an exception here, legislatures have also shied away from designating an individual as a science advisor or an office as a science advisory body. The Maryland project does designate the S&T agent as the science advisor. In practice, his role corresponds closely to that of a staff scientist, and his effectiveness is based upon this organizational placement.

The preference for legislative staff also indicates that legislators prefer to turn to their own resources than to have direct contact with the university community. Indeed, one of the most important aspects of the staff model is that it provides what has come to be regarded as a necessary halfway house between the legislature and the academic community. The most significant illustration of this

point is the Legislative Office for Research Liaison (LORL) project now in operation in Pennsylvania under a grant from NSF. LORL's core staff consists of a staff scientist, with supporting professional staff. LORL performs two major functions. (1) It draws upon its own personnel to provide direct responses to legislative requests for information. (2) It serves as a brokerage unit to pass on legislative inquiries to a consortium of six universities (The Pennsylvania State University, University of Pittsburgh, Temple, Drexel, University of Pennsylvania, Lincoln) which have agreed to cooperate with the project.

This arrangement has several salient features. First, it provides a technical filter through which legislative inquiries for information, which are often quite broad and amorphous, can be translated into more specific questions which will elicit responses. Second, it filters faculty responses to the requests by converting what might be extremely technical material into information that is directly related to the issue as it is perceived by the legislature. In this sense, LORL's staff work is designed to increase the extent to which information provided by university faculty is understandable to the legislature. A special feature of the Pennsylvania project is that the LORL staff unit within the legislature provides the legislature with a broad base of information and thus serves to identify possible disagreements among experts. Moreover, from the university perspective, the LORL arrangement permits each institution to determine its preferred manner of cooperating with the legislature.

Another important aspect of the legislative staff mode is that it has potential for a proactive capability. To this point legislative needs, and indeed, state and local needs for S&T knowledge, have

been analyzed in terms of responses to an existing legislative docket. Analysis has not focused on what is increasingly perceived to be one of the major shortcomings of the political system, namely, that by the time issues reach the "policy agenda," the costs and consequences of attempting to adjust to the issues are greater than they would have been if the issues had been dealt with when they were first identified. State legislatures, with their characteristic high turnover rates among legislators, are severely hampered in their efforts to anticipate and deal with structural changes in American society before problems reach the "crisis" stage. To have what has come to be termed a "proactive" capability, that is, the capability to identify such developments, to make informed projections as to what consequences of these developments will be unless attempts are made to alter them, and to develop the necessary coalitions to insure that action can be taken in anticipation of crisis, requires that legislatures perceive themselves as "policy-initiators" rather than as "policy-reactors" and that they acquire the resources necessary to effectively perform this role. In many ways the legislative perspective truly is "sufficient to the day are the problems thereof." However, when possessed of in-house staff capability, legislators are in a better position to link up with those portions of the scientific and technical communities who are charged or involved with forecasting and analyzing long-term developments and who have suggested prospective courses of action.

The principal means by which state legislatures have sought to improve access to the external scientific and technical communities

is by developing linkages with universities and colleges, most frequently those which receive state funds. Improved relationships with universities have some obvious attractions for state legislatures. Relationships already exist in most states between these two institutions, ranging from formal budgetary arrangements between a legislature and university-based institutes which provide assistance to the legislatures to informal, but possibly significant, ties between individual legislators and individual faculty.

More generally, legislators perceive universities as repositories of a broad range of technical skills. This has special attraction for legislatures in two types of settings. First, in those legislatures which meet for short sessions and/or on a biennial basis, full-time professional staff is regarded by many legislators as a costly, unaffordable luxury. Recourse to the broad-based expertise associated with the organization of a university is seen as an effective alternative source. Second, legislatures tend to perceive their needs for expertise in terms of problem identification, consideration of options, and enactment of legislation. Once the legislation is passed, however, legislatures generally see their role as having ended. Implementation of the legislation is regarded as the province of the mission agencies or the private sector which is presumed to act in response to the set of incentives or sanctions imposed by the legislation. Legislative review of laws or programs occurs primarily through the budget process. Legislators increasingly perceive the oversight function as an important dimension of their reponsibilities, although oversight is still a sporadic activity in most legislatures and as yet has not generated clear long-term needs for additional technical staff. Thus, legislatures, even though they recognize their need for technical information, tend to

see these needs as short-run. They appear to be extremely wary, apparently primarily from fear of constituent backlash over expenditures for legislative services, to commit themselves to the employment of specialized personnel who would not have clearly defined responsibilities once a particular legislative issue had been resolved. The attractiveness of the university as a group of experts who can be consulted or brought in to address perceived short-run problems, thus, has additional appeal.

The question of relationships between legislatures and university systems has been widely discussed within the last several years.[10] While universities are typically seen as a likely source of information, they have not been perceived by state governments as being particularly responsive to their needs. As noted in Power to the States, "Universities are seen by executives and legislative leaders as generally unresponsive and detached from the immediate problems of state governments."[11]

Another observer has described university-state legislative relationships as follows:

> University professors and state legislators often perceive each other through a glass darkly with admittedly discordant features being magnified into stereotyped caricatures. Annual budget battles in which the tendency may be for the Legislatures to cut the executive's request for state-supported institutions, occasional aberrant legislation (such as that concerning the teaching of evolution), and legislative threats to academic freedom (such as calls for the dismissal of politically heterodox faculty) do little to create in the minds of faculty a picture of a body responsive to rational thinking or to offers of assistance.
>
> Legislators, unaccustomed to seeing university representatives in the legislative halls except when the universities are requesting funds, uncertain about the possible political value judgments underlying the 'technical' advice they are receiving, unfamiliar with the decentralized mode of operations

> of major universities, and possibly rejected by academicians in earlier requests for information, have little reason to regard universities as contributing significantly to other activities.[12]

Three general approaches have been attempted in recent years to more closely link state legislatures and universities: (a) the use of interns from science-based disciplines, (b) university-based clearinghouses or technical assistance programs; (c) staff liaison capabilities within a legislatively based unit. The intern approach has been used in Illinois, New York, and Wisconsin Two elements of these programs are worth noting. First, the initial use of interns was generally part of a larger S&T related project, involving a senior staff scientist. Second, the intern was generally employed on project grant funds.

The university-based model has been most fully tested in Alabama, and to a lesser degree in a Pennsylvania project. In Alabama, Auburn University, under a grant from the NSF, undertook the creation of the Alabama Legislative Technical Assistance Program (LTAP). The Alabama project is of importance in weighing alternative delivery systems because one of the principal recommendations contained in its 1976 interim report was the following:

> Considering the nature and extent of current and future policy research and information needs of state legislatures, particularly in areas of science and technology, it is not feasible for state legislatures to maintain permanent in-house resources to meet such needs. Consequently, legislatures with limited research and information resources should develop linkages to external resources on a very broad scale.[13]

The basic work of LTAP entailed providing liaison with the resources of the state's universities, research institutes, regional agencies, and federal agencies. LTAP also arranged for university faculty to serve as the professional staff for legislative committees.

The problems encountered by a similar project conducted in Pennsylvania are of interest, both as an indicator of the difficulties likely to be encountered in the use of the university-based model and because it served in significant ways to affect the design and working rules of the LORL model, which appears to be emerging as a successful prototype for the effective linking of state legislatures and a state's university system. A university-based clearinghouse for scientific and technical information, established under a grant from the NSF to The Pennsylvania State University, preceded LORL. The PSU project had many of the same objectives and work activities as the Auburn project. The principal shortcoming of the Pennsylvania project, and indeed, it seems plausible to argue a shortcoming which, in general, will characterize the university-based systems approach, is that legislators will not turn to university offers of assistance, however well intentioned these may be, unless they (the legislators) have some confidence that the information they will receive will positively correlate with the realities of the issues with which they must contend. Moreover, legislators, while appreciative of the technical expertise presumably widespread among university faculty, are reluctant to uncritically make themselves dependent on the views of individuals whom they may have just met. Thus, universities may offer to supply technical assistance, but legislators may not request it.

It is important to note here one salient difference between the Pennsylvania and Alabama settings which affects the relative attractiveness of university-based systems to state legislatures. The Pennsylvania General Assembly has one of the most fully developed staff systems of American legislatures; Alabama's is one of the less developed. In Pennsylvania, the addition of a staff specialist to focus on S&T-related issues and to serve in a liaison role with the state's university system represents an elaboration of an existing support system In Alabama, where the existing support system is seen as being inadequate to handle the basic flow of legislation, legislative preferences are less for staff to work in any specific area, however broad it may in practice prove to be defined, and more for general-purpose support (e.g., bill drafting). In such a setting, the university system becomes, in essence, adjunct staff.

Needs Assessment

State legislatures have had little reason to formally undertake needs assessment activities, particularly in the fields of science and technology. As emphasized throughout this discussion, legislatures seldom see "S&T" as distinct categories, but rather as elements in broader policy issues. The lack of any clear credibility or political influence on the part of state legislatures with the federal agencies responsible for supporting domestic R&D and the absence until recently within legislatures of the staff to develop R&D agendas have made efforts at needs assessments largely fruitless endeavors.

A major needs assessment activity designed "to systematically identify, evaluate, and prioritize the science- and technology-related problems and needs of the state legislature," however, has been initiated in 1978. The project is being undertaken by NCSL under a grant from the National Science Foundation. Moreover, many of the state plans produced as part of the SSET program will contain statements of the type of information needed by legislatures. Although it is not possible at this time to assess the outcome of the projects, it is useful to consider some of the elements which have served or appear to have served as "pre-conditions" for its conduct. To put it differently, the prospects for a meaningful needs assessment undertaking by state legislatures, defined here to mean the preparation of a cogent and defensible (to federal agencies) R&D agenda, rest upon other improvements in legislative capabilities in the fields of science and technology. The participants in the NCSL project and in several of the SSET projects are the S&T agents, i.e., the technically trained, legislative staff personnel, who have been employed by state legislatures in recent years. Moreover, the MISTIC project has served to familiarize state legislatures with the operations of an information network which is supported by and tied into the federal information network NCSL through its management of the MISTIC projects, its management of a NASA-funded project to increase legislative familiarity with LANDSAT, and through its support role to the legislatures under the SSET program has emerged as a recognized representative of state legislatures in their relationships with the federal government in the S&T field.

Needs assessment activities are also built into some of the larger, state government-university projects. In Alabama, for example, the

activities, described above, of the Legislative Technical Assistance Project led in 1976 to the formation of the Public Research and Technology Program, which was conducted by the Alabama Innovation Group, itself a cooperative effort of the five campuses of the University of Alabama and Auburn University. One of the stated objectives of the project was to establish an R&D agenda for Alabama state and local governments. Three legislators and one legislative staff member sit on a 27 person R&D council. The Council's work serves to define research topics of importance to branches of state and local governments, which then serve as a basis for research contracts between a state or municipal body and researchers at the state's universities.

The impact of needs assessment activities, regardless of the branch of government undertaking them and regardless of whether the statements are intended to influence federal or state decision makers, has yet to be determined. The question may be less how to orchestrate the compilation of these statements so that the users are adequately represented, although this is not an insignificant point, than it is to determine what can be or must be done to induce the organizations which control resources to act on the basis of the needs assessment statements

Footnotes

[1]"State Governments Take on New Vigor," U.S. News and World Report, March 24, 1978, pp. 39ff, p. 39.

[2]William Pound and Carl Tubbesing, "The State Legislatures," in The Book of the States, 1978-79,(Lexington, Kentucky. The Council of State Governments, 1978), Vol. 22, 1-78; 1.

[3]Power to the States (Lexington, Kentucky: The Council of State Governments, 1972), Report and Supporting Analyses, pp. 18-22.

[4]Alan Rosenthal, "Energy-Schmenergy: The Problem is Putting Information to Work," in The Northeastern States Confront the Energy Crisis. A Conference of State Legislative Leaders from the Northeastern States; Report to the National Science Foundation, NSF-RA-G-75-050 (n.d.), 219-236.

[5]Feller, et al., op. cit., pp 26-28

[6]Winnie Austermann, "Can Legislatures Control Federal Funds?" State Legislatures, January/February 1978, p. 12.

[7]John Hardy, "Federal Grants to State Legislatures," State Legislatures, January/February 1978, p. 10

[8]Another proposed expansion of LIS is worth noting At present NCSL is exploring the feasibility of an information-sharing agreement with the Congressional Research Service. Under the proposed exchange, NCSL would obtain access to the Congressional research field and the federal government would obtain access to the LIS. "Nationwide Legislative Information System Under Development," State Legislatures, July/August 1978, pp. 32-33.

[9]Norman Mellor, "Legislative Staff Services Toxin, Specific or Placebo for the Legislature's Ills," Western Political Quarterly 20 (June 1967).

[10]Robert Fairman and Maurice Oliver, eds., A Question of Partnership, Report and Recommendation of the Conference on Institutions of Higher Education as a Resource in the Solution of National Problems (Washington, D.C.: The National Association of State Universities and Land-Grant Colleges, 1972); Ione Phillips, The Added Dimension (Washington, D.C. National Association of State Universities and Land-Grant Colleges, 1977).

[11]Council of State Governments, Power to the States, op. cit., p. 143.

[12]Irwin Feller, "Providing a University-based Science and Technology Input to State Legislatures," State Government, 47:3 (Summer 1974), 142-147; 142-3.

[13]"Improving Policy Research in State Legislatures," Interim Report of the Alabama Legislative Technical Assistance Program (Auburn, Alabama: Auburn University, 1976), pp. 13-14.

Section VI

Local Government

Introduction

Whereas the bulk of state government expenditures are comprised of transfer payments for the support of education and public assistance, the largest share of municipal expenditures are for current operations Local government is the immediate provider of the public sector services with which citizens most directly and most frequently have contact. Thus, the general issues of transferring scientific and technological information when focused on local governments becomes for the most part the more specific question of developing, transferring and incorporating new technologies into urban service delivery systems.

Indeed, as discussed in the opening section of this report, the "public technology" worldview which has shaped not only the general set of national technology transfer objectives but has also strongly influenced the design of federal programs to promote the use of new technologies in the public sector has been based upon the limited scope of technological changes noted for these services. And, again, among the underlying premises for much of the concern and activity at the federal level relating to technology transfer programs directed at local governments is the recognition that there are insufficient market incentives to induce private industry to invest in R&D directed at local government

service delivery and that local governments have demonstrated a resistance to new technologies when such do appear.

A more complete look at some reasons proffered for this purported resistance is useful here because current federally-funded projects to promote the use of technologies by local governments are designed to one degree or another to overcome stated "barriers." These barriers can be grouped under the following headings: institutional rigidity, lack of resources, suspicion concerning the objectivity of intergovernmental technical assistance, fragmentation of the user communities, lack of systematic demand and incentives for improved efficiency, lack of incentives for introducing and implementing innovation.

Institutional Rigidity

Frederick Hayes, a former budget director of New York City, has written that the structure of state and local government was "not designed to be highly efficient, responsive, flexible or innovative."[1] Rather, it was constructed on the premise that the current *modus operandi* was essentially correct; there was little need for change T. Costello, another former New York City official, singled out the political dimension--leadership turnover, heterogeneity in constituency goals and values, and external constraints on autonomous decision-making--as distinguishing the process of change in municipal governments from other types of organizational change.[2] A 1973 conference on productivity cited the following organizational characteristics as inhibiting productivity improvement in state and local governments.[3] (1) Bad performance is penalized more than good performance is rewarded, causing public officials to become risk averters. (2) The

lack of clarity of public objectives makes performance changes difficult to measure and reward. (3) Political survival demands emphasis on short-run results.

For the above reasons, technological products and processes which are adopted by local governments tend to be incremental in scope and in number. Large-scale changes require both innovative thinking and extra staff Local governments are held to have little capacity to design and implement new programs. Innovations of an incremental nature are more likely to be implemented than those requiring radical change.

Moreover, there is a strong inference in this line of analysis that functional agencies are too moribund to capitalize on technological opportunities. In this view, change depends on purposeful leadership from the chief executive.[4] Visibility and political standing are required if the objective of continuous technological modernization of municipal operations is to be taken seriously. This goal can be achieved only through involvement of the chief executive, thus, the intended recipient of general purpose technology transfer programs would have to be a municipal policy center, usually the mayor's office.

Lack of Resources

Local governments typically lack the resources (both time and money) to develop and fund long-range or large-scale programs of technology transfer. Attention and resources are directed toward immediate problems or those known to require important decisions within a specific time frame. Moreover, projects requiring the

expenditures of large sums of money for equipment require the authorization of government officials other than the line agency officials directly involved. Thus, a coalition of support for innovation is necessary. The amount of time required to build and maintain such a coalition of support is not compatible with the lack of continuity of elected local officials.

Suspicion about the Objectivity of Intergovernmental Technical Assistance

Intergovernmental technical assistance, particularly federal assistance, may not be perceived as particularly useful by municipal agency personnel for the following reasons.

Local officials may view such assistance, particularly when it is offered by federal agencies, in an advocacy context. They may see federal agencies as "pushing" a particular technology rather than providing unbiased technical advice. In their study of the diffusion of innovations in municipal governments, Feller and Menzel reported that municipal officials did not rate state and federal publications as important vehicles for becoming informed about new technologies (Table VI-1).[5] These findings suggest that decision makers in local agencies are more comfortable with information supplied by sources with well defined biases than with information supplied by state and federal agencies whose biases are not readily apparent. The findings of Hughes and Olser, using a small sample of California cities, support this analysis.[6] They found other cities to be the overwhelming choice of local officials as the preferred source of new ideas.

TABLE VI-1

Municipal Official's Assessment of Importance of Various Information Sources for Becoming Informed About New Technologies, 20 Selected Cities, 1975

	Very Important %	2	3	4	Un-Important %	Total %
Professional meetings (N=85)	55.3	27.1	11.7	4.7	1.2	100
Formal training programs (N=84)	34.4	31.0	25.0	6.0	3.6	100
Demonstration projects (N=85)	34.0	27.1	27.1	10.6	1.2	100
Other people in my organization (N=85)	32.9	32 9	23.5	9.4	1.2	100
People in other local agencies (N=83)	14.5	36.1	27.7	19.3	2.4	100
People in state agencies (N=84)	7.1	34.5	36.9	17.9	3.6	100
People in federal agencies (N=83)	10.8	21.7	31.3	21 7	14.5	100
Consultants (N=86)	14.0	24.4	29.1	17 4	15.1	100
University specialists (N=85)	7.1	23.5	27.1	27 1	15.3	100
"Tech reps" (N=82)	14.6	35.4	30 5	13.4	6.1	100
Manufacturers (N=85)	16.5	36.5	32.8	11.8	2.4	100
Local distributors (N=83)	11.0	20.7	34.1	17.1	17.1	100
Trade journals/magazines (N=86)	41.9	36 0	19.8	2.3	0.0	100
Professional journals (N=84)	52.4	33.3	13.1	0 0	1.2	100
Manufacturers' literature (N=86)	17.4	38.4	32.5	10 5	1.2	100
University publications (N=84)	9.5	21 4	20.3	26.2	22.6	100
State publications (N=84)	3.6	17.9	22.5	31.0	25 0	100
Federal publications (N=86)	10.5	29.1	27.8	19.8	12.8	100

Source Feller and Menzel, Footnote 6, p 179

Technical assistance offered by federal agencies may be of a kind which local agencies do not need or in a form which they cannot assimilate. The problem of "need" may stem from federal ignorance of high priority local problems. The "assimilation" problem may be the result of the rapid professionalization of federal agencies as contrasted with the slow, uneven professionalization of state and local agencies. Different professionalization rates at the local, state, and federal levels have most probably aggravated the disparity in technical expertise among these levels and caused federal agency personnel to be viewed by municipal officials in somewhat the same manner as are academics--as optuse and irrelevant authorities

Fragmentation of the User Community

Translating needs and priorities into an actionable research agenda is a difficult task, particularly in areas other than the functional programs of federal mission agencies. King argues that, contrary to popular belief, cities do not have common needs, only common deficiencies which may or may not be identified as needs.[7] Thus, one of the principal issues to be addressed in designing any demonstration project or in building an information-sharing or technology-exchange program or organization among any specified set of cities is to determine what, if anything, they have in common. That cities (and states) do turn to one another for information or guidance has been shown in several studies, but these very same studies also point to the great variability in patterns of communication and influence.[8]

Lack of Systematic Demand and Incentives for Improved Efficiency

A variety of reasons have been adduced from analysis of the formal properties of public sector organizations to produce the conclusion that such organizations (which would include local governments) have little incentive to be efficient. (The implicit comparison is with the behavior of profit-maximizing (cost minimizing) firms operating in competitive markets.) One key difference cited between the two types of organizations is the need for governmental leadership to share rewards for managerial decisions with a variety of external organizations and groups (such as legislative bodies, clientele groups, "good government" groups and other committees), while sanctions for "bad" decisions are held to fall solely on those who initiated change. Leadership in the nongovernmental sector is more centralized Governmental bureaucracies also differ from nongovernmental bureaucracies in the following ways: (1) a lack of a high degree of agency control by top executives, (2) a lack of operational measures of effectiveness, such as profits; (3) a lack of clear goals, and (4) a need to demonstrate immediate results because of short terms of office and a high degree of leadership turnover.

The characteristics cited above have the following implications for local government: (1) Lack of centralized top-level control means that the uncertainties associated with the introduction and implementation of innovations are less likely to be tolerated by organization members or by heterogeneous agency clientele groups (2) Lack of clarity of goals and effectiveness measures favors highly visible,

change over changes that might significantly affect long term performance. (3) A rapid rate of leadership turnover favors low-risk, short-term, high pay off programs.

In short, the kind of incentive structure described above encourages local government officials to maximize the budgets of their agencies, not the efficiency by which they operate.

Lack of Incentive for Introducing and Implementing Innovation

Any significant change in the institutions of a complex society requires a perception of a performance gap as well as a change agent or entrepreneur The entrepreneur must understand why the desired change has not taken place and what is required to make it happen. Also, he must be able to identify those individuals whose support or concurrence or participation he needs to put the innovation into effect.

If improvements have not been made because solutions to particular problems are not known, the entrepreneur must start with research, or fact-finding, or discussion to formulate a course of action. If a solution has not been implemented due to limited resources or an environment in which the possibility for change within a program has low credibility, the entrepreneur must find ways to provide the needed resources and to create a more optimistic climate.

Lambright and Flynn report that a local government bureaucracy may require a strong "push" to begin thinking innovatively. However, once the local bureaucracy decides that the innovation is in the local interest, it becomes the primary political and technical force moving the innovation toward adoption, implementation, and incorporation into the operating routines of the organization.[9] Without the

active support of the local bureaucracy, the transfer is likely to be short-circuited at the adoption stage; utilization will be incomplete.

At the local level, the most common focus of technology transfer projects is the office of the city manager or mayor. However, city managers and mayors are not necessarily the best clients for transfer programs, line departments and staff offices, especially budget offices, often make key decisions regarding the adoption of innovative management techniques or equipment. Moreover, executive support for new technology that is not based on realistic expectations may contribute to overadoption of technology. Poorly conceived adoptions of management technologies ultimately may multiply local government resistance to innovation by acting as a catalyst for negative user reactions and organizational inertia. As John McKelvey, President of the Midwest Research Institute, stated during special oversight hearings on the intergovernmental dissemination of federal research and development results in July 1976, ". .the risks of not getting the right technology to the right place are terribly important in economic and social terms. When expectations are raised and unmet, we have problems."[10]

The empirical and analytical basis of the above lines of analyses have undergone critical scrutiny in recent years, most frequently by academic researchers who have begun to study the rate and processes of adoption and incorporation of technological innovations in state and municipal governments.[11] These findings, as noted earlier in the report, do not constitute evaluations of existing technology transfer/information dissemination programs. They are important, however, because they represent a firmer set of empirical findings concerning

what is happening in local governments with respect to the adoption of new technologies than that provided in many of the earlier studies, because they point to the tenuous character of many of the presuppositions concerning processes of technological change and information dissemination in state and local governments, and because they point to a set of strategies different from those currently followed or supported by federal agencies. Among the principal findings which have emerged from recent research studies which have relevance to this report are the following:

The rate and extent of adoption of technological innovations among municipal governments have varied, ranging from rapid and extensive for some technologies to slow and limited for others Although the meaningfulness of comparisons of the diffusion of different sets of innovations among different sets of adopters is open to question, there is little obvious difference in the general configuration of adoption patterns (e.g., lags between date of introduction and adoption by some specified percentage of adopters) between private and public sector organizations.[12]

This finding has several implications. First, assessment of the general receptivity of local governments to new technologies cannot be based on the diffusion of any single innovation which may not be representative of the series of innovations being introduced into local governments. Second, there appears to have been an acceleration since the mid-1960s in the diffusion of innovations across several functional activities of local governments. Third, differences in the rate of adoption across innovations appear to be related to definable performance characteristics, such as technical superiority to existing

techniques and reversibility of adoption. In this respect, diffusion processes in the public sector resemble those held to be characteristic of the private sector. (Indeed, the more fruitful analytical and policy question would appear to be not why public sector organizations are less innovative than private sector organizations, but rather why some innovations in the public sector are adopted more readily and extensively than others.)

* * *

The cost of an innovation has not been found to be a significant indicator of the spread of an innovation. The attenuation of this expected relationship has been attributed to the influence of external (i.e., federal) funding and municipal budget practices which, in many ways, permit the cost of acquisition to be obscured or transferred to subsequent budget years.[13]

* * *

Resistance of municipal governments to new technologies appears in some cases to reflect a "pro-innovation" bias, namely, an assumption that new products and practices are necessarily superior to existing practices and that resistance to the innovations is explainable only in terms of the irrationality or conservatism of the potential adopters. Rejection of or delay in adopting new techniques may, however, reflect a calculation that the innovation is not cost-effective given the price and performance characteristics of its early offering Further, there are indications that such "rational" calculations underly the rejections of municipal governments of some of the more highly publicized examples of the new urban technologies, such as jet-axes, Probe-eyes and automatic nozzles.[14]

* * *

In the service delivery areas where public sector and private sector organizations co-exist, no systematic difference has been found in the response of the two types of organizations to new technologies.[15]

* * *

Patterns of leadership in the adoption of innovations among state and local agencies tend to be highly diffuse, that is, no single state or city emerges as a consistent leader (e.g., early adopter) across a number of innovations within a single functional field. To the extent that there is a concentration of leadership, it tends to occur within specific functional areas rather than being a characteristic of several line agencies within a city or state. This general absence of "innovative" cities or states increases the difficulties which federal agencies will have in implementing "two-stage" or "social-interaction" strategies for promoting the diffusion of new practices.[16]

* * *

The validity of the public sector/private sector dichotomy as a framework and justification for federal technology-sharing programs for state and local governments is a matter of dispute[17] The initial examinations summarized above of the purported backwardness of urban technologies stressed generic differences between public and private sector organizations which made the former inherently more resistant to new practices than the latter. Subsequent analyses suggested that these distinctions were overstated and inconclusive. Roessner, based upon a review of this literature, noted, "Each approach leads, via tortuous, deductive leaps weakened by questionable assumptions about relationships among organizational efficiency, productivity, and innovativeness, to a consistent conclusion. public organizations are

less efficient, and probably less innovative than private organizations."[18]

For the most part, this debate continues, mainly at the conceptional level, with little in the way of comparative, empirical studies.

* * *

The adoption of innovations by municipal governments involves an interactive process of specification in which the characteristics of the innovation are matched with a set of organizational problems. According to Eveland, Rogers, and Klepper, an "...innovation...is not a single unitary thing but rather a set of elements and relationships, the characteristics of what it is and how it is used." The process of specification includes the following stages: (1) agenda-setting; (2) matching (the stage at which a problem on the agenda and an idea for an innovation to solve that problem are brought together and innovation per se begins"); (3) redefining ("the stage at which the innovation's characteristics are defined in terms relevant to the particular organization involved"); (4) structuring; and (5) interconnecting.[19] A related finding by Feller and Menzel (1976) is that given agencies adopt different technologies for different reasons, and that a specific technology may be adopted for different reasons by different adopters.

These findings suggest that the use to which an innovation is put cannot often be predicted by the supplying organization. These findings run counter to the widespread tendancy to view the "n.i.h." (not-invented-here) syndrome as a barrier to innovative behavior. "Reinvention," rather than constituting a costly form of duplication, may be an essential part of the adoption-incorporation process.[20]

* * *

There is growing evidence that the adoption of new technologies does not itself necessarily contribute to improved agency performance, and that indeed federal efforts to accelerate the rate of adoption of technologies by municipal governments may have made it possible for local governments to acquire technologies which are not cost-effective. Danziger's review of the use of computer technologies in municipal governments, for example, suggests that there has been and continues to be widespread adoption of these techniques, even though there is evidence that the gains in agency performance promised for such systems have not been realized in many settings.[21]

Lambright, Teich, and Carroll's study of innovation processes in Rochester and Syracuse, New York, suggests that innovative behavior in municipalities is typically directed at "service improvements" rather than at "cost reductions." While quality of services is an aspect of overall agency performance, the bias in innovative behavior in municipal governments is of note, for it suggests that new technologies will serve to expand the scope of the public sector activities rather than to produce lower unit costs for an existing set of municipal services.

Feller, based on these and other studies, has suggested that public sector innovation may constitute what has been termed "'conspicuous production,' the tendency for nonmarket-oriented agencies to employ new technologies even when adoption is not warranted by 'efficiency criteria,'" and that "public sector agencies may be adopting too little and too much technology at the same time." It is the disparity between innovative behavior and the contribution which innovation can make to agency performance, not the asserted institutionally

induced risk-aversion of these organizations to new technologies, that provides a basis for federal assistance in the adoption-implementation-performance sequence of innovation in state and local governments.[22]

* * *

In sum, the state-of-the-art, at least that derived from research studies, points to a far more complex and variegated picture of the adoption/diffusion/implementation process than is apparent from much of the early accounts of the barriers to the technological modernization of local governments. As was noted at the outset of this report, there is little documented evidence at this date concerning the effectiveness of any but a few of the experiments, demonstrations, projects, etc., which have been initiated in the past decade to promote the use of new technologies. The fact that some of the assumptions upon which these projects were based have been shown to be unfounded does not mean that the projects themselves may not turn out to produce tangible improvements in urban service delivery or in establishing new links between local governments and the scientific and technological communities (including, in this case, private industry).

The demarcations among the classes employed in this report to group approaches, i.e., technology transfer, S&T agents, and information systems, are blurred in the case of local governments, because many of the projects currently in place combine the three functions. Moreover, in the case of local governments, there is a danger of misplaced emphasis on the importance of discrete projects, even if effective, because this focus tends to obscure the presence of a larger, more institutionalized set of "technical assistance" programs operated by other

branches of state governments or by other organizations. For example, a recent survey by the General Accounting Office identified 31 states which had such programs.[23] The scope of impact of these programs is not well described, although they appear to involve elements of technology transfer and technical information. The project descriptions presented below are therefore intended to describe the specific approaches now being supported by federal agencies, and, thus, to denote current (or more appropriately, current at the time that projects were funded) thinking at the federal level as to appropriate strategies to overcome the barriers to innovation in local governments, rather than as a description of the fuller array of possible strategies.

Technology Transfer

For purposes of this report, the project most closely falling into the "pure" technology transfer mode is the Innovations Transfer Project, operated by the International City Management Association under a grant from the National Science Foundation. The stated objectives of the project are (1) to identify operational local government innovations, (2) to evaluate these innovations from the practitioner's perspective, and (3) to disseminate information about the innovations. The project thus first attempts to elicit from the user community itself new "best-practice" techniques. These techniques may be internally generated hardware or software technologies or novel uses of existing technologies. This "grass-roots" genesis presumably means that there is a demonstrated utility to the innovation in local government operations, as contrasted say with the claims of a commercial

vendor of a new project. A key element in the project's strategy is to engage in an on-site verification and assessment of the identified innovations. This verification is conducted by local government officials in the related functional area. By visiting the site, the review team has the opportunity to view first-hand the operational characteristics of the innovation. Again, the strategy is intended to provide nonadopters with peer group assessments of the utility of the innovation. Finally, the project disseminates information about the innovations, including the names of other users of the product.

In its general design, the project resembles the Innovations Transfer Project being conducted by the Council of State Governments. In both cases, the emphasis is on eliciting approaches considered innovative by the user communities. The ICMA and CSG projects do not promote the use of innovations new to the complete community of users, but rather they emphasize the horizontal spread of "grass-roots" solutions.

Although it performs several functions, the Urban Technology System (UTS) is also grouped under the technology transfer heading because the original proposal for support of the project emphasized the role of the system in promoting the diffusion of new technologies among the member cities.

Founded in 1973, with principal financial support from NSF, UTS was designed to test the effectiveness of an integrated technology delivery system consisting of three interlocking components. The components include. (1) a system manager, i.e., Public Technology Incorporated, (2) specially recruited science and technology agents reporting to local government chief administrators, (3) "back-up" R&D institutions that provide active support to the local governments through the S&T agents.

UTS consists of 27 cities in the 50,000-500,000 population size class. Of the 27 medium sized cities and counties participating in UTS when the system became operational in 1974, eight had terminated their participation by 1977. As previously noted, an NSF funded evaluation of the UTS network is scheduled for completion in 1979.

The objectives of UTS as set forth in its original design are to stimulate accelerated technological innovation, market aggregation and nonfederal research and development investment by (1) clearing and increasing communication channels among the system's components, (2) developing more awareness of technological opportunities, needs, and capabilities, (3) promoting education, training and related policies and programs for increasing knowledge of applicable opportunities, and (4) promoting an understanding of market aggregation possibilities "[24]

The key element of the UTS experiment is the use of an S&T agent, usually a scientist or engineer, who is assigned to the chief administrative officer of the participating jurisdiction, who in most of the test sites is a city manager. This positioning of the S&T agent was deemed necessary in order to insure that technical information reached the "right" decision maker and that proposals for new approaches were not buried within the line agencies. The major functions of the S&T agent are to provide the required technical, administrative, planning, or analytical expertise to formulate solutions to problems identified by his assigned city or county. The range of problems addressed by S&T agents in the past five years has been broad, including problems that required the application of either high or low technologies, problems that required the application of well-established rather than newly developed technology, and problems that required only marginal changes

in municipal operations as well as problems that necessitated the establishment of new organizational systems. The S&T agents were responsible for producing a technical brief on each innovation developed. To date, 135 such briefs have been produced, documenting innovative solutions ranging from wetted salt for snow and ice control to disaster warning systems.

To support the S&T agents, UTS has drawn upon resources in Public Technology, Inc., universities, nonprofit research institutes, private industry, federal laboratories, and other regional innovation groups and networks. Each of the 27 test sites is formally linked to one of 16 "back-up sites" which have contractually agreed to support each S&T agent up to specified levels of effort. The "back-up sites" consist of universities, nonprofit and profit-making research organizations, and private firms.

Problem solving efforts at the back-up sites were to consist mainly of rapid-response investigation efforts conducted for a single community and requiring no more than ten days of effort. Each back-up site agreed to provide between one and three work years of rapid-response effort per UTS site over the three-year period of S&T agent activity (1974-1977). Problems with this element of the system have occurred due to the limited funding that was available for problem solving activity of a longer duration. Since responsibility for the technical diagnosis of a problem was not clearly delineated between the "back-up sites" and the S&T agents and the back-up sites were limited to a maximum of ten days effort on any one task, the ability of the 16 back-up sites to address the many urban problems not amenable to quick solutions has been limited.

S&T Agents

The UTS, described above, is also the major test of the use of S&T agents within municipal governments. There are, however, several other projects which employ this approach, with some variations. For the most part, these variations relate to the geographic cluster of cities served by the project, rather than the national scope of UTS. Thus, the California Innovation Group and the Alabama Innovation Group are examples of "networking" arrangements of S&T agents within a state Another distinguishing characteristic of many of these projects is that the technical expertise furnished to the network originates in the universities. Explicitly or implicitly, they represent an application of the agricultural extension model to the urban setting. The final variant of the S&T agent approach considered here is the Baltimore Applications Project which, as detailed below, has several unique features relating to its emphasis on "capacity building" and its emphasis on the process of technology transfer rather than specific solutions.

The California Innovation Group (CIG) is a statewide consortium and network of 11 incorporated cities, one county, and the League of California Cities. The objectives of the Group are: (1) to develop a team approach to solve common urban programs, (2) to establish and institutionalize a statewide technology communication network consisting of cities, science advisors, industry, and the League of California Cities; (3) to develop a more diversified resource base for supporting urban technology development; and (4) to continue the process of internalizing S&T operations within local government.

CIG employs technology agents as an important element in the transfer system. A field agent is placed in each of the cities participating in the network. The agent divides his time between projects that the CIG Advisory Board has identified as being of importance to the Group and specific projects assigned by the City Manager

The CIG is an outgrowth of the California Four Cities Program, an early (1971) NASA-sponsored experiment designed to provide technological assistance to cities. The concept behind the Four Cities Program was to put together a consortium of participants considered essential in providing technology transfer to cities. The program was sponsored by NSF, NASA, the four cities (San Jose, Fresno, Pasadena, and Anaheim, California), and the sponsoring aerospace firms. The four science advisors, provided by the aerospace firms, reported directly to the City Managers. Back-up support for the science advisors was provided by the aerospace firms.

At the conclusion of the Four Cities Program, the General Accounting Office conducted an evaluation of the experiment Their evaluation report stated, "The program generally achieved the specific program objectives and showed that such partnership arrangements can bring about improvements in operating local governments through technological innovations."[25]

The Alabama Innovation Group is an attempt to develop an applied research and technology delivery system which can match state and local governmental problems and needs with university-based problem solving and research resources. The three land grant universities function as the delivery system intermediary. Although the Alabama Program began as a program for municipal governments, its scope encompasses other branches

of government. The explicit strategy employed by the Group is to facilitate a process of accomodation between those with public management responsibility and the suppliers of new technology. The emphasis is on developing agent-based relationships in which the innovator responds to the needs of the user organization. To insure program responsiveness to state and local government needs, all projects undertaken require a request from the government sector and usually the provision of some financial support. Extension field agents provided by the universities play a key role in the program. Program costs are shared by the universities and the participating governments.

The Center for Local Government Technology (CLGT) at Oklahoma State University is an interdisciplinary, university-based center designed to increase the use of science and technology by local governments in Oklahoma. The delivery system is an adaptation of the land grant university approach to agricultural research and extension. Particularly important to the experiment are the "test farm," on-site demonstration and the extension agent concepts. Services are delivered to the chief administrative officers of city and county governments.

CLGT is composed of two divisions--an R&D division which develops specific projects to provide solutions to high priority problems identified by local government officials, and an extension division which transfers solutions by a variety of means to local governments. The extension division also responds to requests for technical information on a quick response basis and serves as a comprehensive referral service to other agencies and organizations. A User Steering Committee, comprised of state and local government personnel, provides guidance to the Center and reviews and endorses all specific projects. Linking

the local government users of the system and the university staff is a group of specialized S&T agents trained in engineering technology.

Although the Center for Local Government Technology was directed to provide engineering and management technology only to county and city units of government in Oklahoma, a 1975 evaluation of the Center suggested the suitability of this approach for any land grant institution located in a rural state. Thus, while the first two phases of the program have identified significant common problems of users, developed "solution packages," and validated the effectiveness of USDA transfer-dissemination mechanisms, the third phase of the program involves: (1) piggybacking the Oklahoma State University experience to the newly emerging technology transfer programs at the land grant universities in Nebraska, Louisiana and Arkansas, and (2) developing, with 15 other universities which are involved in providing technical assistance to local governments, a network to exchange, adapt, and disseminate successful solutions on a regional and national basis.

The Baltimore Applications Project (BAP) is an example of a transfer effort in which a federal agency, i.e., NASA, assumed the role of intermediary between a supplier of technology, the Goddard Space Flight Center, and a user, Baltimore. The program began in 1974. As described in a 1977 report by the National Academy of Public Administration, which evaluated the project, BAP had several characteristics which, in combination, made it unique among technology transfer efforts. (1) The project was initiated by the user--Baltimore City officials; (2) the project was based upon a bilateral agreement between the City and

the Center; (3) the project was free-standing, the terms being established by the City and the Center. There was no formal tie to other technology transfer or utilization systems.[26]

The project focused upon providing practical access to Goddard's technical competence rather than attempting to "sell" available technology. The focus of the project was the process of transfer, not specific products. Moreover, the project provided an opportunity to study the effectiveness of user-pull as a strategy for promoting transfer, thus contributing to the general body of available knowledge on the transfer process.

The BAP represents a distinct departure from previous NASA approaches to technology transfer. NASA's Technology Utilization Program, for example, has focused on secondary applications of existing NASA technology. In contrast, the approach of the BAP has been considerably more of a capacity-building endeavor. The strategy has been for local officials to define their problems. The NASA technology agent has functioned as an intermediary or gatekeeper to technical competence in the NASA laboratory, not necessarily to existing NASA technology.

The BAP undertook three types of activity. (1) consultation and advisory activities, (2) technology demonstrations, and (3) research and development programs. Efforts were concentrated on those City departments considered to be most interested and most likely to have problems which would lend themselves to technological resolution. This strategy had the positive effect of quickly uncovering those problems most amenable to technology. However, the strategy also had the effect of pushing into a secondary position those high priority problems that were less susceptible to technological intervention

The BAP thus far has produced little in the way of new technology that has actually been implemented. It was originally conceived as a bilateral program not directed toward third party benefits. Thus, the BAP did not develop ties with industry to facilitate commercialization of the BAP applications. Moreover, the BAP studiously stopped short of participating in decisions to implement the new technology. Project involvement in agency operating problems and local politics was avoided.

The Baltimore Applications Project clearly was an example of a transfer program concerned more with the process of transfer than with any particular product, in contrast with most of the other projects noted above, which have tended to be product oriented.

Need-Pull

The fragmented nature of the local sector is one of the reasons more frequently cited as a barrier to private sector investment in urban technology. Two projects, the Urban Consortium for Technology Initiatives and the Community Technology Incentives Program, represent attempts at aggregating these markets through the compilation of "user need" statements. These statements, which are derived from the experiences of a cross-section of municipal officials, are intended to reflect the "real-world" technological requirements for operating agencies. The assumption behind the approach is that the statements, backed by the aggregate purchasing power of the members of the consortia, will serve as a sufficient inducement to private industry to invest in the development of the sought after technological solutions. Another use of these statements is the potential leverage they provide local

governments in their efforts to induce federal agencies to orient federal R&D along specific lines.

The nation's 28 largest cities and six urban counties are members of the Urban Consortium, a nationwide cooperative program established in 1974 to select high priority needs for R&D, encourage the transfer of information and technologies, and direct targeted research efforts at the federal level. PTI serves the Consortium in a secretariat function. Consortium activities are based on a highly structured use of "task forces" which encourage interactions among technology suppliers in industry and government to meet defined needs. Task forces, of which there are now ten, are formed to take responsibility for groups of needs in one area. Applying criteria such as commonality and magnitude, the ten highest priority needs in each area are selected. Information bulletins are produced for each of the ten high priority needs summarizing the issues, the state of current practice among urban jurisdictions, current major R&D activities (public and private) and the organizations and individuals involved. When new and promising approaches to these needs are identified by the consortium, the task force designates a User Design Committee with the expertise to test and implement the S&T application. When such approaches cannot be identified, the task force creates a User Design Committee to design and carry out an R&D project that will produce a new product. Upon completion of the R&D, and after prototype testing in selected cities, the User Design Committee develops transfer-dissemination "packages" to guide user governments in implementing the innovation.

The Community Technology Initiatives Program (CTIP) involves the creation of a new organizational basis for assembling, organizing, and delivering applied science and technology solutions to governments

with a population of 50,000 or less. The potential target for this effort comprises some 34,000 cities, counties and townships. It combines the objectives of market aggregation, R&D agenda setting, and information transfer. Established in 1977, CTIP represents 27 municipalities and townships and three counties. Criteria for selection include geographical diversity, a range of governmental form and population size, and a demonstrated interest in utilizing science and technology for public problem solving. The objectives of the CTIP are to (1) define common user needs among smaller localities, (2) provide technical support and information to the users in adapting R&D results to meet cost and performance criteria, and (3) undertake demonstration projects to help market the technology These local governments make up a major purchasing sector in the national economy. CTIP hopes to engage this purchasing leverage.

Efforts at market aggregation to influence either private sector or federal R&D are of too recent a vintage to permit firm conclusions. Although there is a surface appeal to this approach, which is buttressed by citations of the idiosyncratic purchasing specifications of municipal governments and casual observations, such as the job shop atmosphere of any fire truck manufacturer, the effectiveness of user needs statements as a sufficient incentive for either private industry or the federal government to change its ways must be held open to question

Information Systems

The principal example of a municipal science and technology advisory group in municipal government is the Mayor's Science and Technology Advisory Council in Philadelphia.

M-STAC is a mechanism for assembling 150 scientists, technologists and others, including a small management unit, to engage in a continuing dialogue with senior municipal management in Philadelphia for the purpose of identifying tasks to which the skills of various Council members can be applied. In this sense M-STAC functions primarily as an information system for senior city officials. M-STAC consists of volunteers from research institutions, universities, and high technological industries. A small staff operating out of the Mayor's office provides the necessary bridge between the council and the operating agencies. The Council reviews scientific and technological aspects of existing and proposed municipal programs, maintains and establishes needs assessments, and evaluates and documents M-STAC operations and impacts. Currently, M-STAC is working to extend the reach of the Council to the entire Philadelphia metropolitan area and to complete the independent institutionalization of the Council as an adjunct to municipal government

The continued viability of this Council is all the more impressive considering the fragile existence most such bodies have had in state and local government. In general, the short and less than productive life spans of such groups leads one to doubt if the approach has much to offer local governments as a means of tapping the pool of scientific and technical personnel residing in a city or its environs. The Philadelphia case suggests that an advisory enterprise is not inherently doomed to failure, although, as is the case with the atypical success of the governor's science advisory project in Michigan, the unique features that separate the "successes" from the larger number of failures are not readily apparent.

Footnotes

[1]Hayes, op. cit., p. 8.

[2]T. W. Costello, "Change in Municipal Government: A View from the Inside," in L. A. Rowe and W. B. Boise (eds.) Organizational and Managerial Innovation: A Reader. Pacific Palisades, California: Goodyear, 1973.

[3]National Commission on Productivity in State and Local Government. Report on the Wingspread Conference (July) 1973.

[4]James Perry and Kenneth Kraemer, "The Chief Executive in Local Government Information Systems: Catalyst or Barrier to Innovation," Urban Systems 2 (1977), pp. 121-131.

[5]Irwin Feller and Donald Menzel, Diffusion of Innovations Among Municipal Governments (University Park, Pa.: Center for the Study of Science Policy, 1976), Report to the NSF, Grant DA-44350.

[6]Peter Scott Hughes and Milton Henry Olsen, A Regional Center for Utilization and Transfer of Technology. M A. Thesis. Naval Postgraduate School, Monterey, California, September 1976, p. 77.

[7]James King, "Improving Local Government Capacity: An Odyssey," Seminar entitled Transferring Science, Technology, and Innovation in the Public Sector. Where Are We? Where Should We Be? Sponsored by SRI International in cooperation with the Intergovernmental Science, Engineering and Technology Advisory Panel, December 7, 1977, p. 8.

[8]Jack Walker, "The Diffusion of Innovations Among the American States," American Political Science Review, 63 (September 1969), pp. 880-899; Virginia Gray, "Innovation in the States: A Diffusion Study," APSR 67 (December 1973), pp. 1174-85, Donald Menzel and Irwin Feller, "Leadership and Interaction Patterns in the Diffusion of Innovations Among the American States," Western Political Quarterly 30 (1977), 528-536; Feller and Menzel, op. cit.

[9]W. Henry Lambright and Paul Flynn, "Bureaucratic Politics and Technological Change in Local Government," Urban Analysis 4 (1977), pp. 93-118.

[10]Review of Intergovernmental Dissemination of Federal Research and Development Results, Special Oversight Report No. 5, House Subcommittee on Domestic and International Scientific Planning and Analysis of the Committee on Science and Technology, U.S. House of Representatives, Ninety-fourth Congress, Second Session, July 1976, p. 39.

[11]This section is based upon the principal investigator's paper, "Research Finding and Issues in the Design of an Intergovernment Science System," Paper prepared for the Office of Science and Technology Policy, Executive Office of the President, January 1979.

[12]Irwin Feller and Donald C. Menzel, "The Adoption of Technological Innovations by Municipal Governments," Urban Affairs Quarterly, 13 (1978), 469-490.

[13]Feller and Menzel, op. cit.; Lambright, Teich, and Carroll, op. cit.

[14]Feller and Menzel, op. cit.

[15]Louise Russell and Carol Burke, Technological Diffusion in the Hospital Sector, National Planning Association, Report to the National Science Foundation, Grant No. RDA75-14274, 1975.

[16]Menzel and Feller, op. cit.

[17]Marshall Meyer and Robert Williams, Comparison of Innovation in Public Sectors: An Exploratory Study, University of California, Riverside, Report to the National Science Foundation, Grant No. PRA-19967.

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Section VII

Summary

Since the mid-1960s an acceleration in the rate of utilization of publicly developed technologies and scientific and technical innovation by state and local governments has remained a consistent objective of the federal government. However, the specific reasons cited for these objectives have changed. In the mid-1960s, increased utilization of advanced technologies and scientific and technical personnel was tied to the goal of economic conversion and was intended to pick up the slack in the product market for aerospace firms and the labor market for scientists and engineers. In the mid-1970s, the emphasis shifted to the need to increase productivity in the service delivery systems of state and local governments. There are strong parallels in the objectives contained in President Nixon's 1972 Message on Science and Technology and President Carter's directive to the heads of federal agencies in 1977. Congressional statements over this period have expressed a similar interest in increasing the rate of utilization of federally sponsored research and development.

Pursuit of the above goals continues, despite a mixed record of success during the past decade Some historical perspective on a 1970 Conference on the Application of Science and Technology to Public Programs may be illustrative here.[1] This conference was held during the first great public awakening to potential applications of technology to domestic problems. At the conference many examples were cited of

organizational, managerial, and technological innovations that could potentially be applied to the amelioration of a host of domestic problems. Among the more noteworthy examples were the following: modular housing, produced by Stirling Homex Corporation; creation of a New York City Rand Institute to bring about a systematic application of analytical skills to urban problems; and some specific technologies, such as slippery water (later renamed rapid water). During the short span of years between that conference and the present time, the organizations have become defunct; the technologies have experienced limited use. Similarly, many state level efforts to draw upon scientific and technical advice through the creation of governors' science advisory boards or the creation of state science engineering foundations have proved to be of limited value.

Despite these failures, state and local government efforts to bring about the greater utilization of technical information continue. Within state legislatures, no formal or discrete S&T-related activity existed in 1970, today, several viable institutions are operating. The number of local governments involved in various technology transfer programs is far greater today than in the early 1970s. Similarly, state governments continue to apply new technologies and to develop internal staff capabilities to handle the growing complexity of their policy agendas. The tone of the federal/state debate over national energy policy has highlighted the state governments' insistance on being involved in the formulation of a national energy policy. Debates concerning the content of such a policy have supported the contention that state governments must be in a position to engage in technical critiques of plans developed at the federal level.

Indeed, one of the great difficulties in assessing federal/state/local relationships in technology transfer and research utilization is the fact that any such examination covers a period of only ten years. A sense of perspective is absent in many of the assessments of specific projects and broader approaches; the type of changes that may be necessary to produce a more effective system for intergovernmental transfers of technology and information may require a longer period of time to develop than is customary for "project" activities. In many cases, what is required are adjustments not only in formal relationships, but also in personal relationships. These changes involve credibility and trust, attributes of relationships which usually evolve slowly.

It may be useful at this point to look more carefully at the experience of the agricultural extension system, which is frequently cited not only as the model of the systematic application of science and technology but which also has served as a specific base upon which various new proposals have been designed. The agricultural extension system today is deeply instilled into the fabric of American agriculture. Although the system has not escaped recent criticism, it still remains the best example of an arrangement for harnessing technology for domestic purposes through an effective linkage of user and supplier communities. The history of the system, however, shows that its evolution was not without controversy. What is looked at today as a seemingly inexorable outcome of shared objectives and efficient approaches is instead the product of approximately 130 years of debate, discussion, controversy, and reformulation. The dates of the landmark events in the evolution of this system should themselves be regarded as a measure of the time it took to firmly establish itself. According

to True[2] and to Knoblauch,[3] the principal historians of agricultural research in the United States, these dates are: 1846--a professorship in analytical chemistry at Yale University; 1862--the Morrill Act, 1865--the Hatch Act; 1906--the Adams Act; and 1935--the Bankhead-Jones Act. There is thus a sense of time-warp to the inevitability and frictionless evolution of the agricultural extension model, now firmly in place, and a sense of frustration at times and uncertainty about the viability of current efforts

The focus of this report has been on the development of federally supported programs to promote the transfer of technical information and technology. This orientation reflects the current view that existing relationships between state and local governments and the technical communities (e.g., private industry, universities, professional associations, etc.) are not adequate. This recognition has led to the development of new organizations and new approaches. With a few exceptions, such as the market aggregation activity in local government, inadequate attention has been focused on how impediments to the flow of technology between private industry and state and local government can be removed.

There is also a need for greater recognition on the part of the federal government of the disparities that exist among state and local communities concerning interest in and ability to compete for federal assistance. For example, with regard to information systems such as NTIS, the form in which federal assistance has been provided is based on an assumption that there is a support structure which can easily be assigned to search for and digest information. This support structure is lacking in many state capitols. In other state capitols, however,

state governments are well-staffed and well-supplied with the hardware and software accoutrements of modern information systems. The federal government, to date, has not fully understood the implications of this disparity in capabilities. At times it appears to be content simply with information retrieval, often accessed through computer technology, without understanding that for many users simple access to information is not sufficient. What state and local government most sharply lacks are the personnel to obtain such information, and, perhaps more importantly, to translate it into a form which is meaningful in the context of executive policymaking or legislative debate.

The state-of-the-art assessments provided in this report derive from two sources: evaluations of existing projects and research findings. The two do not easily fit together. The projects in many ways reflect efforts at manipulating levers or relationships that were identified in an earlier body of research. Recent research has tended to question many of these relationships. However, these recent research findings cannot be interpreted as being evaluations of existing projects. The newer research findings point to new sets of relationships, but do not themselves provide specific programmatic guides. Moreover, the relationships that have been identified as crucial do not readily lend themselves to federal intervention. Thus, probably less is known about what comprises successful technology transfer and information dissemination programs than is reflected in the analytical framework which has produced existing programs.

Such a seemingly agnostic conclusion has considerable value. It suggests at the outset that federal policy remain flexible. It suggests also that individual federal agencies do not commit themselves too heavily to any single course of action until more evaluations

of existing projects are completed and until a clearer idea is derived of how recent findings can be converted into operational programs.

There are, moreover, specific findings from the state-of-the-art review which do bear directly upon the future of federal programs. The processes by which state and local governments search for and accept technology varies by functional area. The process of adoption, incorporation, and utilization of scientific and technical information is heavily dependent on the interaction of a set of variables, whose influence is heavily conditioned by the specific setting in which the technology or information is to be based. These findings suggest that it will be very difficult to design a single policy or approach which will be applicable in many settings.

Variables and relationships found significant in one setting have been found to be not significant or significant in the opposite direction in other settings. These findings point to the considerable difficulty that federal agencies will have in operating in the push-mode, either for technologies or for information. It also suggests the potential utility of the alternative approach to securing greater utilization of technology and information, namely, strengthening the internal capabilities of user communities to make more informed decisions. This is a high-risk strategy for federal agencies in that by strengthening the capabilities of state and local governments, they (federal agencies) increase the likelihood that they will be dealing with assertive, independent entities, that may become even more reluctant to accept federal assistance than at present. The policy dilemma here, if it may be called a dilemma, is that the current set of intergovernmental relationships do not seem to be producing the desired flow of information and expertise. It is common to regard this resistance of state and local governments to federal solutions

as a failure of the user communities to accept the correct solutions. A major rethinking in federal perceptions of the strengths and weaknesses of state and local governments to make independent judgments about technical information may be a necessary first step before any new programs can be designed.

Footnotes

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