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ABSTRACT

Commencing as a reasonably funded research and development enterprise, the Regional Educational Laboratory Program has become an undercapitalized knowledge transfer operation, an "information utility," responsible for improving schools but constrained by inadequate funds and restrictive policies which confine the labs to working "with and through" state and local education agencies. Drawing upon Office of Educational Research and Information (OERI) program documents and recent syntheses of research on knowledge transfer, this paper explores the following questions: (1) How does the laboratory program compare with similar or analogous initiatives in areas such as agriculture, industry, defense, and health? (2) What new strategies might be developed to enhance the performance of regional educational laboratories in improving schools? and (3) How can regional educational laboratories improve their performance in transferring knowledge which helps revitalize American schools? The central argument of the paper is that regional educational laboratories are vital elements of a complex social system of educational knowledge. It is suggested that it might be prudent to focus resources on the design and conduct of quasi-experimental field studies involving alternative strategies for transferring educational research and development to those who need it. (JD)

LABORATORY POLICY PAPER

REGIONAL EDUCATIONAL LABORATORIES: THE STRATEGY OF USABLE IGNORANCE

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This is one of several papers about the regional laboratory program, or functions which laboratories perform, which the Office of Educational Improvement (OERI) in the U.S. Department of Education has commissioned. The purpose of the papers is to assist planning for the 1990 recompetition of awards to operate regional laboratories. This paper has been written under contract to the U.S. Department of Education. No endorsement by OERI or the Department of Education should be inferred.

REGIONAL EDUCATIONAL LABORATORIES: THE STRATEGY OF USABLE IGNORANCE

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INTRODUCTION

The Regional Educational Laboratory Program is considerably more complex today than it was some twenty-five years ago when the first laboratories were established under Title IV of the Elementary and Secondary Education Act (ESEA) of 1966. In those early years the Educational Laboratories, along with Research and Development Centers, were faced with the apparently simple task of revitalizing schools by generating and diffusing new knowledge regarding learning and instruction (see Guthrie, 1989, pp. 3-4). In the intervening years laboratories, working in an increasingly complex environment comprised of diverse local educational priorities and political interests, were reorganized along regional lines. To be sure, the process of regionalization fostered greater responsiveness to states in that fiscally troubled era known as "creative federalism." Nevertheless, the process of regionalization has created a complex tapestry of conflicting agendas which tend to complicate the further development of a common educational mission.

The process of regionalization has been attended by a stunning decline of funds available to the nine laboratories and its sponsors, the National Institute of Education and (after 1985) the Office of Educational Research and Improvement.

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The laboratory program, like other federal R&D initiatives designed to promote social goals, has experienced deep fiscal cuts in a period when the share of total federal R&D devoted to the military function grew from 51 percent in 1975 to 72 percent in 1986 (National Science Board, 1985, p. 226). The Reagan-era military build-up, an integral part of what many see as a nascent "military-post-industrial complex", evidently has been purchased at the expense of education and other social programs.

Given this unhappy conjunction of circumstances, it is perhaps readily apparent why the mission of the Regional Educational Laboratory Program has changed over the years. Commencing as a reasonably funded R&D enterprise, the program soon became an undercapitalized knowledge transfer operation, what some see as an "information utility" responsible for improving schools but constrained in this effort by inadequate funds and restrictive policies which confine laboratories to working "with and through" state and local educational agencies. Unclear, however, is how the laboratory program functions as a vehicle for the transfer of educational knowledge. How do individual laboratories and the program as a whole link or mediate producers, users, and intended beneficiaries of new educational knowledge? How does the laboratory program compare with similar or analogous initiatives in areas such as agriculture, industry, defense, and health? What new strategies might be developed to enhance the performance of regional educational laboratories in improving schools? How can regional educational laboratories improve their performance in transferring knowledge which helps revitalize American schools?

In responding to these and related questions this paper draws on OERI program documents and recent syntheses of research on knowledge transfer, including Beal, Dissanayake, and Konoshima (1986), Dunn and Holzner (1988), Dunn, Holzner, and Zaltman (1985), Glaser, Abelson, and Garrison (1983), and Huberman (1987, 1989). The central argument of the paper is that regional educational laboratories are vital elements of a complex social system of educational knowledge. The organized complexity of this system renders firm programmatic commitments to improving schools through knowledge transfer activities hazardous; it also raises doubts about the appropriateness of school improvement as a standard of accountability, since the resources presently available to laboratories do not permit them to impact directly upon schools. Assuming that a dramatic increase in laboratory funding is unlikely, it may be prudent to focus resources on the design and conduct of quasi-experimental field studies involving alternative strategies for transferring educational R&D to those in need. In contrast to the current practice of "random mediation," these quasi-experimental interventions would represent a form of "systematic mediation" designed to contribute in important ways to the expansion of institutional and system-wide learning about the efficacy of alternative knowledge transfer strategies. But the immediate aim of systematic mediation is not to transfer what Lindblom and Cohen (1979) term usable knowledge, but rather to identify what Ravetz (1987) calls usable ignorance. The strategy of usable ignorance, which involves the coding, classification, and specification of gaps in our knowledge about effective approaches to synthesizing, developing, and disseminating educational R&D, can help set the research agendas of the educational research community and shape the policy-making and practice agendas of state and local policy makers, teachers, and other stakeholders in school improvement.

LABORATORIES IN THE KNOWLEDGE SYSTEM OF EDUCATION

The current and historical performance of the Regional Educational Laboratory program can be investigated in several ways, for example, by examining changes in the political mandate, legal charter, and mission of laboratories (OERI, 1988), or by exploring the organizational and political conditions which have enabled and constrained their effectiveness (Guthrie, 1989). Although these approaches are no doubt valuable and important, the laboratory program also can be investigated as a system of norms, values, roles, and resources forming the social arrangements within which knowledge-related activities are carried out. Here, the central organizing construct is that of the social system of knowledge, or knowledge system for short, which refers to the social distribution of knowledge-related functions (Holzner and Marx, 1979, p. 175).

Knowledge Functions

The regional educational laboratory program, like all knowledge systems, performs several interrelated knowledge functions: mandating, production, structuring, storage, distribution, and utilization (see Holzner, 1983; Holzner, Dunn, and Shahidullah, 1987).

- Knowledge Mandating. The laboratory program involves decisions about what kinds of research should be mandated and, indeed, whether research of any kind is the proper function of laboratories. The priorities of the program since 1985 reflect the decision that laboratories should function primarily as regional "information utilities." As such, the research conducted by laboratories should be limited, short-term and applied in nature (NIE, 1985, p. 25).

- Knowledge Production. Although laboratories are not responsible for conducting basic research, they are formally charged with the conduct of applied research and development which yields systematic assessments of effective approaches to dissemination and school improvement (NIE, 1985, p. 13). In practice, the bulk of such new knowledge appears to be based on "random mediation," that is, the initiation of dissemination activities which are evaluated by means of casual empiricism and ad hoc analysis.

- Knowledge Structuring. Laboratories structure existing knowledge by synthesizing, evaluating, and transforming into potentially actionable products basic and applied research produced by R&D Centers, universities, and other institutions within the knowledge system. Newsletters, policy papers, research syntheses, and other laboratory products represent efforts to structure (and restructure) knowledge which is believed relevant to school improvement.

- Knowledge Storage. Laboratories use conventional filing systems as well as computerized records to store knowledge which has been produced locally and by others. The creation of computer files comprised of annotations of existing written reports, or of available computer software, involves the storage of knowledge.

- Knowledge Distribution. Laboratories distribute to various stakeholders, including state and local educational agencies, knowledge which has been produced, structured, and stored. The distribution, dissemination, or communication of such knowledge by laboratories is intended to improve schools.

- Knowledge Utilization. Although laboratories themselves utilize the knowledge they produce, structure, store, and distribute to others, the principal direct users of this knowledge are the state and local agencies with and through whom laboratories are mandated to work. Unless knowledge is utilized in some way to improve schools, its dissemination by laboratories is practically meaningless, although utilization alone by no means guarantees a specific impact (positive or negative) on schools.

Knowledge Structures

Regional Educational Laboratories perform these functions in markedly different ways. In the area of improving state-level educational policies, for example, only five of nine laboratories report that they specialize in functions of knowledge structuring, storage, and distribution, as represented by the categories "data base development" and "data base reports" presented by Mason (1988, Table 7). Although laboratories produce new knowledge, few appear to conduct systematic research on their own role and effectiveness in developing and disseminating products of educational research and fostering their utilization. Evidently, laboratories could learn a good deal more about their own performance as knowledge-mediating structures (Holzner, Dunn, and Shahidullah, 1987) or intermediaries in the so-called market for educational knowledge (Sundquist, 1978).

Laboratories thus appear to have a limited capacity for monitoring and evaluating their own knowledge system interventions, interventions which are designed to link basic and applied educational researchers, on one hand, and educational policy makers and practitioners on the other. One possible explanation for this limited capacity has to do with the unique professional culture of laboratories, which is significantly different from that of R&D Centers and research universities, both of which are formally committed to the norms, values, and interests of scientific communities. In contrast to scientific communities in which new knowledge has intrinsic intellectual value (see Machlup, 1980), laboratories represent a special form of social and cultural organization which MacRae (1987) calls a "technical community." A technical community is

> a group of experts who deal with laymen's practical problems, conduct related research, and subject both these activities to independent mutual quality control. Such a group resembles a scientific community except that it is guided by practical rather than purely theoretical criteria of excellence; and concerned not only with internal standards but also with performing functions for, and thus interacting with, laymen (MacRae, 1987, p. 5).

As technical communities laboratories are the principal intermediaries in a complex knowledge system in which distinct knowledge functions are distributed among different institutional structures. These functions and structures are sometimes viewed as forming a linear or quasi-linear arrangement, where one structure performs a specialized knowledge function which is followed, in turn, by the next structure performing its function, and so on. This view is eloquently stated by Rothman (1980, p. 16), who employs the metaphor of a missing lumber mill to represent obstacles to the effective transfer and utilization of knowledge in education and other human service areas:

> The sociol science researchers have gone into the forest of knowledge, felled a good ond sturdy tree, and disployed the fruits of their good work to one another. A few enterprising, application-minded lumberjacks hove dragged some logs to the river and shoved them off downstreom ("diffusion" they call it). Somewhere down river the proctitioners are manning the construction companies....on the whole they are sorely lacking in lumber in the various sizes and forms they need to do their work properly. The problem is that someone has forgotten to build the mill to turn the logs into lumber in all its usable forms. The logs continue to pile up ot one end of the system while the construction companies continue to make do at the other end....

The strength of this metaphor is that it emphasizes the important role of mediating structures in linking producers and users of knowledge. The limitation of the metaphor is that it assumes o process which is essentially linear, unidirectional, and irreversible.

The metaphor of the missing lumbermill does not accommodate knowledge systems in which different institutional structures perform one or many knowledge functions which are arranged in the complex spatial and temporal patterns described by Reisman (1987) and applied to the oreo of knowledge systems accounting by Dunn, Holzner, Shahidullah, and Hegedus (1987):

- Serial. A mediating structure performs specializea functions which have one predecessor and one successor in a series, for example, when the distribution of new educational knowledge is preceded by prior basic or applied research and succeeded by knowledge utilization by practitioners. A predecessor or successor function may have its own predecessor and successor, creating an extended series of functions which form a chain-like arrangement which is linear, unidirectional, and irreversible.

- Parollel. A mediating structure performs a number of parallel knowledge functions which have no clear predecessor or successor, or, by extension, several structures perform two or more porallel series of functions. For example, two porollel series involving the production, distribution, ond utilization of educational research may be performed by different progroms within the some laboratory, or by two or more loborotories. The resultant arrangement, while unidirectional and irreversible, is co-lineor.

- Assembly. A medioting structure performs a speciolized function which involves the assembly of results from ony number of predecessors, for example, when new educotional knowledge is assembled from multiple sources which ore "scientific," "professional," ond "experiential."

When laboratories assemble knowledge in this fashion the resultant pattern, while irreversible, is multi-linear and multi-directional.

- Arborescent. A mediating structure performs a specialized function with any number of successors which form the branches of a tree, for example, when the conclusions of an educational research project are developed in the form of multiple products. Laboratories often develop products in this arborescent fashion, forming a tree-like arrangement which is multi-linear and multi-directional, although it remains irreversible.

- Cyclic. A mediating structure performs specialized functions with a number of predecessors and successors which are cyclically related, with feedback loops among functions. In most mediating structures, functions are cyclically related, not linear, although it is frequently difficult to establish their temporal order. For example, the approach employed by laboratories to develop and disseminate research products affects their utilization by practitioners, who in turn may affect subsequent development and dissemination efforts by providing evaluative feedback. The resultant arrangement, which is expressly non-linear, can be found as well in parallel, assembly, and arborescent structures which have feedback loops.

Organized Complexity

Knowledge systems may be characterized in terms of organized complexity, a state or condition in which the interpenetration of serial, parallel, assembly, arborescent, and cyclic patterns forms a complex but organized arrangement. While sometimes erroneously equated with random or chaotic processes, organized complexity is usefully represented as a complex river delta which systems analyst Stafford Beer (1981, p. 30) calls anastomotic reticulum. In this complex river delta many streams flow to the sea or to the flood plain, with the streams branching repeatedly, flowing into each other. Until we comprehend the organized complexity of the delta it is not possible to forecast the likely route of a pailful of water dumped upstream in the river; nor is it possible to trace the route by which a pailful of water drawn from the sea arrived there. While the water moves in a central direction towards the sea, the system continuously changes as a consequence of dissipative and self-organizing structures. Old streams disappear and new ones form; order emerges out of chaos (compare Prigogine and Stengers, 1984).

The imagery of the river delta punctuates some of the profound difficulties which arise when observers try to trace practical problem solving to prior knowledge functions, but without first attempting to comprehend the organized complexity of the mediating structures and functions which form the knowledge system. Observers such as Lindblom and Cohen (1979), Weiss and Bucuvalas (1980), and Glaser, Abelson, and Garrison (1983), for example, report essentially weak or equivocal relationships between the production and utilization of knowledge in education and many other areas of social practice. But weak or equivocal relationships also have been reported in science and technology intensive areas such as agriculture, industry, health, and defense which are widely but mistakenly believed to be unambiguous beneficiaries of federal investments in research and development. A recent international project devoted to the design of science and technology impact indicators (Dunn and Holzner, 1987), while yielding several prototype indicator systems, produced few stable and empirically grounded conclusions about specific social and economic impacts of the natural and social sciences in areas of government information policy (Bearman, 1988), industry (Feller, 1987), health (Kochen, 1988), and education (Rutherford, 1987).

Organized complexity thus appears to generate weak or equivocal functional relationships in many of the most important knowledge systems. While two decades of research (see Havelock, 1969) suggests that the strength of linkages among elements of such systems is a critical aspect of knowledge transfer, such functional linkages often have been found to be weak or equivocal. When functional linkages are weak or equivocal, it is difficult to predict the social and economic impact of scientific knowledge. Illustrations of this difficulty may be found in areas of agriculture, defense, industry, and health:

- Agriculture. One of the most well-funded and ambitious knowledge systems is that of the Cooperative Extension Service (CES) of the U.S. Department of Agriculture. Although the "agricultural model" has many unique characteristics that cannot be generalized to other knowledge systems--for example, the relative simplicity of seeds, fertilizers, and other material innovations--the CES appears to have performed reasonably well (Havelock, 1969, p. 3-35). At the same time, recent studies of the economic impact of the CES (e.g., Weaver, 1985) suggest that the prediction of agricultural improvements on the basis of investments in R&D is problematic. Although there is a positive relationship between indicators of agricultural output (e.g., sales) and indicators of R&D (e.g., expenditures), the absence of specific measures of the process of diffusion makes these indicators at best "stochastic measures of the unobservable input characteristics and output flows involved in the R&D process" (Weaver, 1985, p. 14).

- Defense. Large investments in the knowledge system of military R&D are often justified on the basis of subsequent economic impacts on the civilian economy. The C5-A transport, for example, significantly affected the development of the Boeing 707 and other improvements in civil aviation. Yet as Rosenberg cautions, the opportunity costs of military R&D to the American economy appear to have been substantial. "The economic growth experience of the United States in the past few decades, by comparison with Japan, Germany, and other advanced industrial countries, does not obviously support the presumption that large expenditures on military R&D have improved its relative economic performance" (Rosenberg, 1985, p. 42).

- Health. Advances in biomedical R&D have enlarged capacities to prevent and treat infectious diseases. Although the decline in mortality from infectious diseases is seen by many as the most significant medical achievement of modern times, a careful investigation of historical evidence "seems to show unambiguously that medical science has made only a marginal contribution to this practical achievement" (Mulkay, 1979, p. 73). Observing that the long-term decline in deaths from cholera, tuberculosis, typhus and other infectious diseases occurred many years before the introduction of science-intensive technologies into medical practice, Mulkay (1979) and Knorr-Cetina (1981) argue that basic and applied science typically exert weak effects on health improvements.

- Industry. Scientific R&D may be viewed as the engine which drives industrial improvements of many kinds. At the same time, detailed studies such as Wealth From Knowledge: A Study of Innovation in Industry (Langrish et al., 1972) document that dozens of award-winning industrial innovations in the United Kingdom have been weakly related (if at all) to prior advances in basic or applied science. In the United States, this conclusion would seem to be supported by Griliches (1984, p. 18), who observes that relations between scientific R&D and productivity "can be affected only indirectly and imperfectly by supporting science in general and basic research in particular and by pursuing wise macroeconomic policies." This general claim may be related, in turn, to the specific conclusion that "policies intended to affect the technological infrastructure through the use of various transaction devices (grants, contracts, procurements, mandating of technology, etc.) are based largely on legal and accounting criteria, and have little demonstrated relationship to innovation outcomes" (Tornatzky et al., 1983, p. 221).

As these examples suggest, the organized complexity of knowledge systems in agriculture, defense, health, and industry frequently involves weak or ambiguous functional relationships. Knorr-Cetina (1981) and Mulkay (1979), in using the relationship between biomedical research and infectious diseases as a critical case, go beyond ad hoc accounts of knowledge systems and develop a plausible general explanation of the sources of such organized complexity (also see Prigogine and Stengers, 1984). Observing that most of the 1850-1970 decline in deaths from infectious diseases occurred prior to the adoption of science-intensive technologies by practitioners, they argue that social practice is underdetermined by basic and applied science. Scientific and technological knowledge tends to dissipate in complex social systems where functional linkages are weak and where social practice is temporal, contextual, and self-organizing (Knorr-Cetina, 1981). In medicine as well as education, basic research is used as a foundation for technological innovation only after extensive reformulation. "In order to make basic science 'work,' it has to be radically reinterpreted in accordance with the requirements of the social context of practical application .... judgments of cognitive adequacy vary with social context" (Mulkay, 1979, p. 71). These processes of radical reinterpretation make it difficult to disentangle the effects of science and other forms of specialized knowledge from the effects of experiential or craft knowledge originating in contexts of practice, thus complicating efforts to justify research in terms of its practical utility.

Rosenberg (1986) provides a summary statement which establishes a general baseline for assessing the impact of science-intensive technologies on industry, agriculture, health, defense, and education:

> Perhaps the reason we do so poorly at predicting the impact of technological change is that we are dealing with an extraordinarily complex and interdependent set of relationships. We should, however, be able to do a somewhat better job of it in the future, if only by developing a better appreciation of some of the reasons why we have done so badly in the past (Rosenberg, 1986, p. 17).

THE DISSIPATION OF EDUCATIONAL KNOWLEDGE

By recognizing the organized complexity of knowledge systems it is possible to comprehend why research-based educational knowledge, whether basic or applied, loses force and direction as it makes its way from producers through intermediaries to users. The more complex the knowledge system, the greater the tendency of knowledge to dissipate as a consequence of self-organizing structures and functions. The more pronounced the tendency toward dissipation, the stronger the intervention required to transfer knowledge with the aim of producing a desired effect.

Economics of Weak Interventions

The financial resources available to OERI and the laboratory program govern the extent to which promising knowledge transfer interventions can be successfully mandated. The strong interventions required to forestall or to minimize the dissipation of educational knowledge are possible only with adequate levels of funding. Yet the funds available to OERI and the laboratory program permit only weak interventions which, lacking in potency, are unlikely to succeed in the transfer and utilization of knowledge for school improvement. As Rutherford (1987) observes, the mediating structures established by NIE/OERI in the form of the regional educational laboratories and centers have made little progress in the last quarter century toward placing the conduct of elementary and secondary education on a scientific basis. Among several plausible explanations for this lack of progress it appears that laboratories, in contrast to the massive resources provided to land-grant universities under the Morrill Act, are based on mechanisms which "are too feeble to have much impact on such a huge enterprise as education" (Rutherford, 1987, p. 308).

The feeble character of these mechanisms is evident in the continuous decline of the budget of the regional educational laboratory program since 1973 (Table 1). In constant (1972) dollars the budget of the laboratory program fell from $22 million in fiscal 1973 to $6.5 million in fiscal 1988, a decline of more than 70 percent. During the same period the budget of the National Institute of Education/Office of Educational Research and Improvement fell by more than 79 percent, from $98.8 million in 1973 to $20.6 million in 1988. While the budgets of NIE/OERI and the laboratory program declined, federal government expenditures on military R&D increased by approximately 90 percent, from $8.6 billion in 1973 to $16.2 billion in 1988. Nearly all of this increase in military R&D and roughly one-half of the decrease in funding for OERI and the laboratories occurred during the Reagan presidency. To place these changes in perspective, to restore laboratory funding to its 1973 level would require a tripling of the fiscal 1988 budget.

Random Mediation

Although laboratories are designed to mediate the worlds of producers and users, it is presently unclear how they perform functions of knowledge mandating, production, structuring, storage, distribution, and utilization. The descriptive synthesis of laboratory approaches and activities prepared by Mason (1988), together with program summaries provided by each of the nine laboratories (OERI, 1989), suggest that few laboratories are identical or even similar in the functions they perform. Observed differences between laboratories have been viewed as a natural and appropriate response to regional diversity, as a means to adapt creatively to a complex environment. Conversely, these differences also may be seen as a failure to adhere to common standards of performance.

Regrettably, neither of these views is correct, since creative adaptations to complex environments can and should be linked to common standards of assessment. Consider, for example, the 1985 Request for Proposals (RFP) requiring that laboratories "contribute to knowledge about effective strategies for improving education through carefully designed studies of how its own dissemination and improvement efforts are working" (NIE, 1985). Provided that laboratories conduct such carefully designed studies, variations between laboratories can only strengthen efforts to cross-validate and evaluate the performance of competing dissemination and improvement strategies.

Inter-strategy variation is therefore essential to the success of the laboratory program. For example, the deliberate maximization of differences between alternative dissemination strategies can help alleviate a severe problem identified by Lieb-Brilhart (1989, p. 1) on the basis of a 1988 report to the House Committee on Education and Labor of the U.S. Congress:

> ...there has yet to emerge a national dissemination policy of exploiting, in a coordinated fashion, the strengths of existing dissemination systems ... as well as identifying what other dissemination strategies are needed to meet the needs of today's schools (Subcommittee on Select Education, 1988, p. 12).

Most laboratories have not commissioned or conducted carefully designed dissemination studies which maximize inter-strategy variation. When well-designed studies have been carried out, for example, the tracer studies commissioned by the Appalachian Educational Laboratory, the use of a special methodology precludes comparisons across strategies employed in other regional laboratories. In fact, the majority of regional laboratories appear to engage in a form of random mediation, as distinguished from the kind of systematic mediation proposed in the 1985 RFP as a promising line of applied research involving "systematic assessment of dissemination and school improvement activities to identify approaches that are most effective" (National Institute of Education, 1985, p. 13).

Systemati mediation can and should employ the logic of quasi-experimental reasoning, whether in the form of the field experiment (see, e.g., Cook and Campbell, 1979) or as case study analysis (Yin, 1985). Both forms of quasi-experimental reasoning, apart from surface differences in technique, are intended to address the equivocality of knowledge claims in complex settings of practice. Quasi-experimentation is a potent approach to systematic mediation because the equivocality of causal inferences involving presumed impacts of dissemination and improvement strategies necessitates methods for systematically ruling out the rival hypotheses which pervade real-life policy settings (see Campbell, 1988, pp. 315-333).

For every hypothesis that educational R&D is (or is not) responsible for a practice improvement we typically must rule out numerous rival hypotheses involving knowledge-mediating functions and structures (see Dunn, 1986). Policymakers and practitioners do not immediately or automatically utilize educational R&D to make practice improvements; nor is there any obvious positive or negative relationship between the improvement of schools, on one hand, and the production, structuring, storage, distribution, and utilization of educational R&D on the other. To be sure, there is a certain surface plausibility about claims that educational knowledge presented in the form of such documents as What Works: Research About Teaching and Learning (U.S. Department of Education, 1986) facilitates school improvement. On closer examination, however, such claims reflect what has been called a knowledge-driven model of research utilization (Weiss, 1977; Yin and Moore, 1988), a model which assumes that educational R&D is the primary or sole source of practice improvements. The knowledge-driven model unwittingly ignores the organized complexity of knowledge systems, along with the tangled interpenetration of specific knowledge functions and structures, thereby assuming a direct or unmediated relationship between the production of knowledge and its impact on intended users.

An important variant of the knowledge-driven model is the simple expected utility model frequently employed to estimate the probable impact of producing research-based knowledge or information (see MacRae, 1985, p. 11). For example, the production of R&D has a total cost, c, which includes expenses incurred for collecting, analyzing, and interpreting data and reporting the conclusions or recommendations in some appropriate form. The probability that the conclusions or recommendations will make a difference is p, while the magnitude of this difference, d, represents its positive impact over and above the benefit, b, which would have been obtained without producing educational R&D. The magnitude of the difference, d, may be added to the original benefit, b, to give an estimate p(b+d) of the net impact or value added by producing R&D.

The simple expected utility model, while expressed formally in terms of symbolic notation (c,p,d,b), supplies a reasonable approximation of informal processes of reasoning employed by policymakers facing questions about the costs and practical benefits of educational R&D. But the simple expected utility model, whether applied formally or as part of the tacit logic-in-use of policy makers, ignores the positive and negative impacts of mediating functions and structures. These mediating functions and structures can be investigated systematically by expanding the simple expected utility model to include positive, negative, and null effects of utilizing educational R&D. Here we estimate the probability that utilizing as well as producing educational R&D will result in positive impacts, no change, and negative impacts (Figure 1). In some cases involving questionable or erroneous research, the non-utilization of R&D can have positive effects.

[Figure 1 about here]

The expanded expected utility model, while it incorporates the probable effects of utilizing and not utilizing educational R&D, does not include the other knowledge-mediating functions of mandating, structuring, storage, and distribution. Even if these additional functions were included, we have yet to develop an empirically well-grounded theory of knowledge applications (Dunn, 1986, p. 198). In the absence of such a theory the knowledge required to calculate such expected utilities can be acquired on the basis of anecdotal evidence and trial-and-error learning in practice settings, that is, on the basis of what we have called "random mediation." Alternatively, this requisite knowledge can be acquired on the basis of quasi-experimental studies involving "systematic mediation." As matters now stand, however, neither the simple nor the expanded expected utility model enables plausible causal inferences about the impact of mediating functions and structures on school improvement.

To assess the impact of these mediating functions and structures we require, in addition to quasi-experimental field research, a framework which identifies the many rival hypotheses which have been offered to challenge claims about the impact of educational R&D on school improvement (see, e.g., Dunn, Holzner, and

Zaltman, 1985; Dunn, Holzner, Shahidullah, and Hegedus, 1987; Glaser, Abelson, and Garrison, 1983; Hubermnn, 1987; Rutherford, 1987). These rival hypotheses represent threats to the plausibility of claims that observed impacts on schools are due to variations in aspects of one or more of the following functions: mandating, production, structuring, storage, distribution, utilization. Table 2 presents a sample of these rival hypotheses, which represent potential sources and forms of error in assessing the impact of educational R&D on school improvement.

[Table 2 about here]

THE STRATEGY OF USABLE IGNORANCE

A major advantage of systematic mediation is its capacity to specify and investigate plausible rival hypotheses, thus contributing to what Lindblom and Cohen (1979) call usable knowledge. Yet systematic mediation, at least in the short run, is more likely to produce what Ravetz (1987) calls usable ignorance. Given the organized complexity of the knowledge system of regional laboratories, it would be surprising if systematic mediation did not yield conclusions of the form: We presently do not know which approaches to knowledge transfer and school improvement are most effective. For such ignorance to be usable, however, what is not known must be placed in a category which Merton (1987) appropriately calls specifiable ignorance. As important as it is to know what is known about the production, transfer, and utilization of educational R&D, it is equally important to

> ...classify, codify, and thereby specify what needs to be discovered, collected, found, developed and/or solved....Dmitri I. Mendelyeev (1889) led the way in this regard. By reflecting on the work of others he classified, codified, and thereby unified a major portion of chemistry of his day. But he did more; the voids in his Periodic Table specified what was yet to be found. Some of these voids exist to this day. Though they defy discovery, they are real voids in knowledge nevertheless (Reisman, 1989, p. 67).

Usable ignorance, defined in this way, is distinguishable from inadvertent ignorance (i.e., error) as well as deliberate ignorance (i.e., fraud) in the natural sciences and medicine (see, e.g., Kohn, 1986) and in the applied social sciences (see e.g., Campbell, 1987; also see Ravetz, 1971). In contrast to inadvertent and deliberate ignorance, usable ignorance is likely to be adaptive (see Reser and Smithson, 1989), at least to the extent that laboratories and other institutions within the educational knowledge system are freed from unrealistic and guilt-inducing obligations. For example, the obligation to produce "usable," "practical," or "applicable" knowledge is frequently unattainable in real-life settings of great complexity, where the creation of usable ignorance is often a first step to devising appropriate solutions. The strategy of usable ignorance can facilitate systematic mediation by classifying, codifying, and specifying what needs to be discovered to make progress in producing, transferring. and utilizing educational R&D for the improvement of schools. In designing a strategy of usable ignorance laboratories and their sponsors might consider innovations in three areas: agenda setting, organization design, and methodology development.

Agenda Setting

Many of the most important problems facing regional laboratories are problems which have been characterized as "messy" (Ackoff, 1974), "squishy" (Strauch,1976), "divergent" (Mason, 1988), or "ill structured" (Simon, 1973; Mitroff, 1974). The problem of knowledge transfer for school improvoment is an ill structured problem because it is embedded in the organized complexity of the knowledge system of education. This system, as we have seen, is usefully viewed as a complex river delta with tangled and interpenetrating branches. Like other ill structured problems (see Dunn, 1988), the problem of knowledge transfer for school improvement hos severol importont chorocteristics: ombiguous or unknown gools; indeterminote or unknown phoses through which gools moy be ochieved; ombiguous or unknown strotegies for ochieving gools through phoses; ond on unbounded ond hence unmonogeobly huge domoin of potentiolly relevont goals, phoses, ond strotegies.

Under these conditions it is essentiol thot loborotories creote usable ignoronce by codifying, clossifying, ond thereby specifying whot needs to be discovered in order to ochieve success in transferring knowledge for school improvement. Lieb-Brilhort (1989), for exomple, hos chollenged the ossumption thot "redundont" information from multiple sources hos overlooded educotionol policymakers ond proctitioners. In controst to this blonket opposition to redundoncy, Lieb-Brilhort (p. 11) specifies whot is not yet known by hypothesizing thot redundoncy is unlikely to be successful in oreos of informotion ocquisition ond storoge; but redundoncy moy be oppropriote ond useful in oreos of knowledge utilizotion, synthesis, communicotion, ond implementotion.

As these exomples suggest, it is not precise single solutions to well structured problems thot should dominote the ogendos of regionol loborotories; rother it is multiple opproximote solutions to ill structured problems which orise from the orgonized complexity of the educotionol knowledge system. Indeed, when precise single solutions ore odvonced os onswers to ill structured problems, we ore likely to find so-colled Type III errors: Formuloting precise solutions for the wrong problems (see Roiffo, 1968; Mitroff, 1974; Dunn, 1988). In o context of concern with the ogendo-setting process of regionol loborotories the following recommendotions see oppropriote:

- o Loborotories should be rewarded for creoting usoble ignoronce through the discovery of octionoble reseorch problems in oreos of knowledge synthesis, storoge, development, disseminotion, ond utilizotion. The incentive systems of loborotories should encouroge the discovery of practically important problems, along with strategies which might clarify or alleviate these problems, not the ritualistic counting of products developed and disseminated to various groups or the listing of superficial "needs" or "preferences." An appropriate system of incentives will maximize the likelihood that laboratories strive to discover such problems and place them on their own agendas and those of the wider educational research and policy-making communities.

- Laboratories should be rewarded for developing appropriate research proposals for investigating problems placed on research agendas, even if no funds are available to carry out the proposed studies. The best of these proposals should be made available to all regional laboratories for their consideration and future use.

- Laboratories should compete for awards which would be made available to those who have discovered actionable research problems and/or developed appropriate research proposals for the clarification or alleviation of these problems. Results of quarterly or annual competitions, along with the winning problems and proposals, should be published in the official newsletter of the Regional Educational Laboratory Program.

By providing institutional incentives for the discovery of actionable research problems, and the development of research proposals which address these problems, the laboratory program would expand capacities to classify, codify, and thereby specify what needs to be discovered, found, or solved. Usable ignorance would be available at a time when usable knowledge is generally unavailable because of the organized complexity of the knowledge system in which laboratories function.

Managing Pragmatic Validity

The professional culture of laboratories is that of the technical community (MacRae, 1986), which is responsible for what may be called pragmatic (as distinguished from merely scientific) validity. In contrast to scientific communities, technical communities are guided not only by the theoretical and methodological criteria of excellence associated with scientific validity, but also by pragmatic validity as it is manifested in adherence to criteria of excellence in clarifying, alleviating, and solving practical problems. In scientific communities with relatively well-codified rules there are many reported deviations from criteria of theoretical and methodological excellence (see, e.g., Kohn, 1986). But numerous deviations from criteria of practical excellence have been reported in technical communities which, working in the applied physical and social sciences, have few codified rules (see, e.g., Snyder, Stevens, and Tornatzky, 1983). In discussing deviations from scientific validity in the applied physical sciences Ravetz argues that:

> ...the application of scientific inquiry to new practical problems should be even more hazardous than the management of deeply novel results within science itself. To the extent that the investigation of problems loses its protective framework of accepted and successful methods, it becomes exposed to pitfalls of every sort....an immature field, in chaos internally, experiences the additional strains of hypertrophy, and its leaders and practitioners are exposed to the temptations of being accepted as consultants and experts for the rapid solution of urgent practical problems. The field can soon become identical in outward appearance to an established physical technology, but in reality be a gigantic confidence-game, combining the worst features of entrepreneurial and shoddy science. The dangers of such corruption are at present more acute for some of the social sciences and technologies (especially those using mathematical and computational tools) than for the natural sciences, since they are related to the most urgent practical problems and they lack a base in fully matured disciplines (Ravetz, 1971, pp. 399-401).

The work of the regional laboratories is prone to deviate from criteria of scientific and pragmatic validity. The reasons for such deviation are rooted in part in the social and political arrangements which affect the structuring, storage, distribution, and utilization of scientific research. In the physical sciences the achievement of scientifically valid results is

> a product of the mutually reinforcing (rewarding and disciplining) scientific community. The validity of scientific truth claims does not come from the innate or indoctrinated honesty and competence of a single scientist. It comes, rather, from competitive replication and criticism, from fear of humiliation due to failed replication efforts, from competition for discovery and eminence so organized as to disclose (rather than cover up) error, incompetence and fraud (Campbell, 1987. p. 3).

In education and other applied social sciences the achievement of results which have scientific and pragmatic validity is likewise a product of the social system of applied science. The success of the regional laboratories is likely to depend on the degree to which the educational knowledge system fosters mutual criticism and self-criticism, encourages a joint commitment to work on shared problems, and generates competition for rewards set aside for those who generate usable ignorance by codifying, classifying, and specifying what needs to be discovered, developed, and/or solved to effectively transfer knowledge for school improvement. In this context, several recommendations are worthy of consideration:

- Laboratories should be rewarded for conducting research and practice syntheses, as well as standard meta-analyses, which expose significant sources of error and bias in the conclusions and recommendations of educational researchers and practitioners. These syntheses and meta-analyses promote mutual criticism and self-criticism within a framework of commonly accepted standards, fostering the discovery of usable ignorance.

- Laboratories should be rewarded for replicating, cross-validating, and evaluating promising synthesis, development, and dissemination strategies attempted elsewhere. Replication, cross-validation, and evaluation facilitate the search for usable ignorance.

- The unit of evaluation and object of incentives (rewards and discipline) should be the synthesis, development, and dissemination strategy, not the laboratory, the laboratory program, or the laboratory staff. The evaluation of strategies, by focusing on specific mechanisms for enabling practice improvements, depersonalizes rewards and discipline, minimizes deviance from accepted professional standards for reasons of self-preservation, and enhances awareness that failures are not personal but stem from the organized complexity of the knowledge system.

By developing an incentive system which encourages the effective management of pragmatic validity, laboratories should have greater capacity to realize standards of excellence appropriate for a technical community.

Methodology Development

Regional laboratories need methods appropriate for investigating and shaping the organized complexity of the educational knowledge system. By now it is clear that most methods available to laboratories, and to the social science research community as a whole, are incompatible with problems which have exceeded a given level of complexity (Brewer and de Leon 1983, p. 125; also see Dunn, 1988). This principle of incompatibility is particularly relevant to problems of assessing the impact of laboratories which function in a knowledge system characterized by organized complexity. In this context several recommendations appear worthy of consideration:

- Laboratories should develop common evaluation methodologies which are systemic in nature. In contrast to bean-counting procedures motivated by an understandable desire for self-preservation, systemic methodologies would focus on the interrelationships and interdependencies among the range of knowledge functions performed by laboratories. For example, the mediating functions performed by laboratories may be represented as a matrix or network which displays spatial and temporal linkages between key knowledge functions: mandating, production, structuring, storage, distribution, utilization.

- Laboratories should abandon what may be called "terminal" impact indicators, instead developing "enabling" impact indicators. Enabling impact indicators would measure and assess the extent to which a given function--for example, the structuring of knowledge by means of research and practice syntheses--enables the successful performance of another function such as the development of multiple products (product differentiation) targeted at different groups of policymakers and practitioners.

- Laboratories should build on past NIE-sponsored research on the conceptualization and measurement of knowledge utilization by developing new profiles, inventories, rating scales, and indexes which capture the complexity of the process of utilizing knowledge. It is widely accepted that knowledge is rarely used instrumentally, for example, to make a policy decision. Instead, knowledge is most often used conceptually, for example, in cases where new research on teaching and learning is used by principals and teachers to develop new "working vocabularies" which alter the way they think about problems of school improvement and their potential solutions.

The methodological recommendations presented above are responsive to the constraints and opportunities facing regional laboratories as key institutions within the knowledge system of education. These recommendations are closely related to knowledge systems accounting (Dunn and Holzner, 1987), an approach and methodology which draws on prior efforts, first in the 1930s and then in the 1960s, to developing national economic accounting and social systems accounting. Social systems accounting, established in an era of large-scale public intervention to alleviate pressing social problems (The Great Society), yielded indicators suitable for evaluating social policies and programs. Knowledge systems accounting, evolving in an era of large-scale public investments in science and technology (The Post-Industrial or Knowledge Society), is a systemic methodology which is appropriate for monitoring and evaluating impacts of the interpenetrating and tangled functions which, performed by laboratories and other mediating institutions, create the organized complexity of the knowledge system of education.

CONCLUSION

The org nized complexity of the educational knowledge system, formed by the interpenetration of tangled knowledge functions which appear as a river delta, raises doubts about the appropriateness of school improvement as a standard of accountability. The stunning decline of federal funds available to laboratories reinforces such doubt, since weak interventions in the knowledge system of education are unlikely to have large or even discernible impacts upon the improvement of schools. The paucity of resources available to laboratories has been partly responsible for an indirect service strategy where laboratories operate as "information utilities," performing mediating functions in a manner characterized as "random mediation." Random mediation may be gradually replaced with "systematic mediation" by conducting quasi-experimental field studies directed toward the classification, codification, and specification of what needs to be discovered to effectively transfer knowledge to those in need. This strategy of usable ignorance, supplemented by recommendations in areas of agenda setting, managing pragmatic validity, and methodology development, is a way to deal with the organized complexity of the knowledge system of education.

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Table 1

FEDERAL R&D EXPENDITURES BY FUNCTION, 1973-1988
(constant 1972 dollars)[1]

Function	73	75	80	85	86	87	88	Change 73-88	Change 80-88
MILITARY R&D ($billions)	$8.6	$8.1	$8.4	$12.5	$13.4	$14.3	$16.2	88.5%	92.8%
CIVILIAN R&D ($billions)	7.7	7.3	8.4	6.8	6.7	6.7	6.4	-16.8	-23.8
NIE/OERI ($millions)	98.8	47.6	41.9	21.8	20.5	21.6	20.6	-79.1	-50.8
LABORATORIES[2] ($millions)	22.0	13.6	9.9	6.1	7.0	6.7	6.5	-70.5	-34.3

SOURCES: National Science Board, Science and Engineering Indicators--1987 (Washington, D.C.: National Science Foundation, 1987); National Science Board, Science Indicators: The 1985 Report (Washington, D.C.: National Science Foundation, 1985); and "Brief History of Regional Educational Laboratories and Research and Development Centers" (Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement, March 1988).

[1] Constant 1972 dollars calculated from GNP price deflators supplied by the U.S. Department of Commerce.

[2] Figures for FY1987 and FY1988 exclude funds for the Rural Initiative.

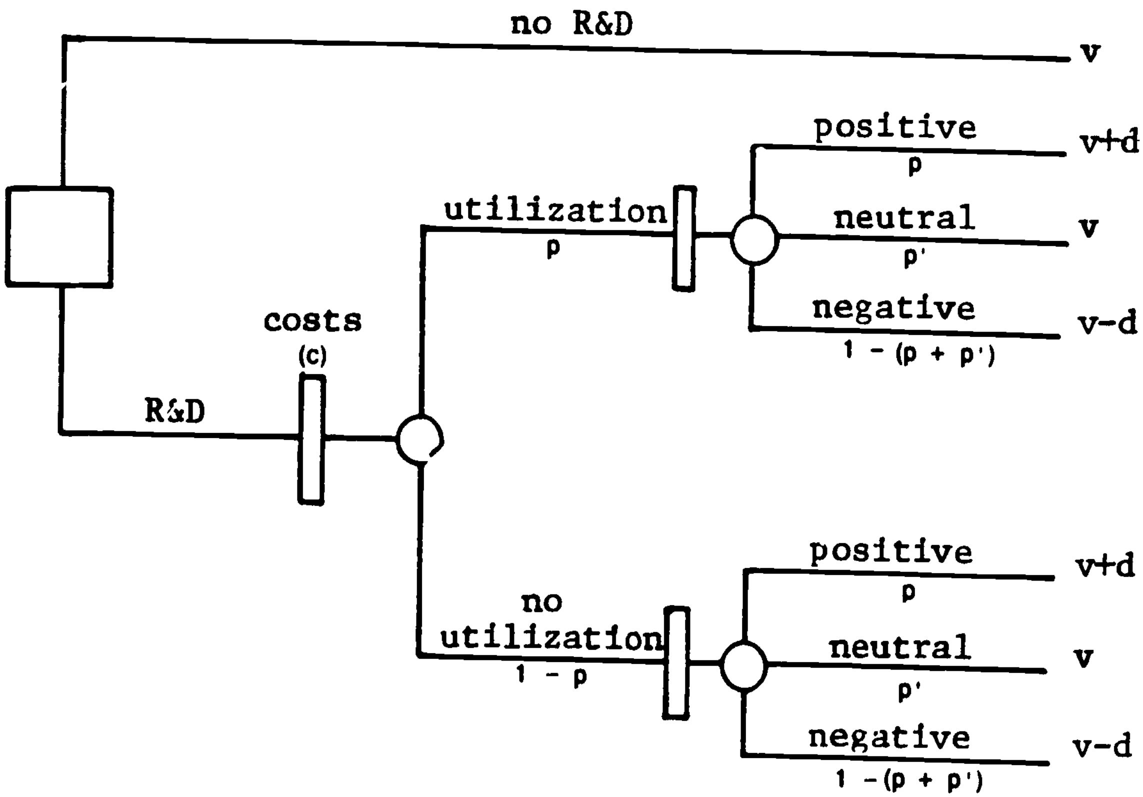

Figure 1

EXPECTED IMPACT OF EDUCATIONAL R&D

Table 2

SOURCES AND FORMS OF ERROR IN ASSESSING THE IMPACT OF REGIONAL LABORATORIES ON SCHOOL IMPROVEMENT

Source	Rival Hypothesis
AMBIGUOUS ASSESSMENT CRITERIA	Dimensionality Bias. A single dimension of R&D utilization (e.g., decisional use) is confounded with another dimension (e.g., conceptual use), making assessments of the laboratory's impact equivocal.
	Source Bias. A particular source of knowledge (e.g., casual empiricism) is confounded with another (e.g., science), making assessments of the source of a laboratory's impact equivocal.
STRATEGIC INFIDELITY	Strategy in Use. The strategy actually used by a laboratory (e.g., political bargaining) is confounded with its publicly espoused strategy (e.g., networking or environmental scanning), making assessments of the reasons for a laboratory's impact equivocal.
	Multiple Strategy Interference. Multiple strategies of development or dissemination are carried out simultaneously (e.g., mass mailing and targeted mailings of products), making assessments of the reasons for a laboratory's impact equivocal.
	Strategy Non-Replicability. A laboratory strategy is so vague or general (e.g., "social interaction") that it cannot be repeated twice, or in more than one context, making assessments of the reasons for the laboratory's impact equivocal.
MATERIALS BIAS	Sequence. The sequence of presenting ideas or conclusions in a laboratory document (e.g., using the "pyramid" principle in news releases) is confounded with the content of the document and the strategy of dissemination, making assessments of the reasons for a laboratory's impact equivocal.
	Format. The format for presenting ideas or conclusions (e.g., case-wise rather than variable-wise displays) is confounded with the content of the document and the strategy of dissemination, making assessments of the reasons for a laboratory's impact equivocal.
	Translation. The process of translating conclusions from technical into non-technical language, or from descriptions into prescriptions, creates departures from original research-based findings and a loss of information, making assessments of the reasons for a laboratory's impact equivocal.

Table 2
(continued)

PRODUCER-USER INCONGRUENCE	Multiple Interpretation Interference. The subjective interpretations of R&D by laboratory personnel and intended users are sufficiently different that the impact of R&D cannot be separated from the impact of its interpretation, making assessments of the reasons for a laboratory's impact equivocal.
	Latent Function. The latent functions of research, development, dissemination, and utilization--for example, political control, program subversion, symbolic legitimation, ritualistic compliance--are confounded with manifest functions such as school improvement, making assessments of the reasons for a laboratory's impact equivocal.
CONTEXTUAL VARIATIONS	Structure. The spatial and temporal pattern of knowledge functions performed by a laboratory--for example, serial, parallel, assembly, arborescent, cyclic--is confounded with a development or dissemination strategy, making assessments of the reasons for a laboratory's impact equivocal.
	Maturation. Processes of learning occurring within users of laboratory products are confounded with the effects of dissemination strategies, making assessments of the reasons for a laboratory's impact equivocal.
	History. Events other than a development or dissemination strategy (e.g., an election or teacher strike) produce effects which are confounded with the effects of the strategy, making assessments of the reasons for a laboratory's impact equivocal.
	Solution-Regression. Pressures for solutions tend to occur when problems are most severe ("The problem must get worse before it gets better."), creating a regression towards normality which is independent of the effects of a strategy, thus making assessments of the reasons for a laboratory's impact equivocal.

SOURCE: Adapted from Dunn (1986), Table 1, pp. 205-206.