panel helps ensure early and successful implementation when results become available. Implementation is first considered in the problem statement and begins with the proposal. Checkpoints are potentially useful tools for study progress reviews. In this way, a proper course can be maintained. Useful results should be disseminated early to help expedite the implementation process. The various reports, interim and final, should be well organized and prepared and should be written in the language of the user.

Even after the final report is prepared, successful implementation is not guaranteed. Effort is still required. If all of the previous steps were properly followed, then the implementation step will be relatively simple. Implementation is not complete until the results are put into use through the media of practice. It is of no value to develop new improved materials or techniques if there are no specifications, standards, or procedures to ensure application. Research results must be implemented to ensure maximum benefits. This does not mean that all results should be applied, since some results are negative. Some steps that have been identified and described for research implementation are the following:

1. Identification—this is accomplished in the problem-identification phase or through the review of results developed by others that have a potential benefit.
2. Planning—this is started during the problem-identification phase and continued through proposal preparation to the completion of the research.
3. Packaging—this is accomplished with the report and any additional documents for the media of practice to ensure proper implementation.
4. Promoting—this is started with the research proposal and is primarily done by the researcher and the advisory panel. It is completed when the results are adopted.
5. Adoption—this is accomplished when the results are accepted in the media of practice to solve the problem or to satisfy the need originally identified.
6. Evaluation—this phase includes the final identification and documentation of the measurable benefits.

If all steps are properly followed with the involvement of key personnel, then the measurements of effectiveness by different management levels and by different disciplines would be comparable.

There are three basic types of implementation efforts. The one I have been discussing is where research has been conducted in response to a problem and the results are implemented to solve the problem. The second type is where the problem exists, and information for the solution is obtained from outside sources, then adopted for use by the organization. This involves to some degree a transfer of technology. The third type is where a problem has not been specifically identified but information has been identified that, if and when implemented, the system would be improved or costs could be reduced. Implementation packages prepared by one agency are effective tools in bringing usable results to the attention of other agencies in a form that they can easily adapt. Implementing results developed by others can significantly reduce time and money by the using agency.

If the research program is set up in a manner similar to the one discussed, with key personnel involved throughout all phases, then there should be agreement on the effectiveness of the program. Everyone is looking for essentially the same thing and their expectations are the same. It can be frustrating and embarrassing to find solutions to nonexistent problems or to find the wrong solution through misdirection of the research effort. A properly planned, organized, and conducted research program does not always ensure 100 percent successful results, but it certainly does improve the chances of producing worthwhile results, whether positive or negative. The manner in which research is planned and conducted and the results implemented plays a significant role in determining how effective the research program will be.

How we measure the effectiveness of a research program depends to a great extent on our point of view and on our expectations. We hope to be able to resolve any differences and develop a system that can be applicable to any level of management or discipline in measuring the effectiveness of a research program.

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Examination of Techniques to Enhance the Utilization of Research Results

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During the past several years, transportation problems have become increasingly more severe in spite of a growing effort to expand the state of knowledge in transportation. A considerable amount of quality research is conducted, but there appears to be a breakdown in the process of transferring these research results into practice. Much effort is devoted to the conduct of research; however, in many cases, the process of implementation and research utilization are ignored. This paper examines the research process and emphasizes major problem areas that hamper implementation within this process. Several barriers to the implementation of research results are identified and discussed. Attention then turns to the results of a study of the characteristics of transportation research conducted at universities and funded by the Urban Mass Transportation Administration program of University Research and Training. On the basis of the results of this study and a review of the literature, eight basic principles relevant to the process of research implementation are presented in conjunction with mechanisms for increasing the level of implementation. These principles demonstrate a need for greater communication between researcher and user and a need for the users of research to become involved in all phases of the research process.

Many researchers have recognized that, despite the

large volume of applied research, too often the results of this research are not implemented. During the past several years, transportation problems have become increasingly more severe in spite of a growing effort to expand the state of knowledge in transportation. A considerable amount of quality research is conducted, but there appears to be a breakdown in the process of transferring research results into practice. Much effort is devoted to the conduct of research; however, in many cases, the process of implementation and research utilization are ignored. This paper examines the process of research utilization and the barriers that hamper this process. In addition, an attempt is made to establish some general principles that can be used to overcome some of these barriers. The problem of research implementation addressed in this paper will be couched in terms of urban transportation research conducted at universities and targeted for state or local user agencies. Nevertheless, we believe that the basic principles and processes discussed are applicable to almost any research context.

It is important at the outset to distinguish between basic and applied research, for this distinction will serve to narrow our focus. Colman (1, p. 2) and Haworth (2, p. 116) believe that the distinction is based on the intent of the researcher. A researcher engaged in basic research is primarily interested in the advancement of knowledge (i.e., contributing to the theory of a discipline or area of inquiry). In applied research, the researcher has practical, specific objectives. That is, the expectation is that the research will have some practical utility for others. Further, the applied researcher often expects that the results of the research will influence the decisions of people who are in a position to effect policy change.

THE RESEARCH PROCESS

Research almost invariably involves the same sequence of steps:

1. Recognition of the problem,
2. Problem definition,
3. Theory building and explanation,
4. Information gathering,
5. Information analysis and interpretation,
6. Development of conclusions,
7. Formation of recommendations, and
8. Implementation and action.

The potential usefulness of a research project can be affected by the way in which each of these steps is undertaken. If there is a substantial deviation in how things are viewed by the researcher and how they are viewed by the user, the likelihood of eventual implementation is decreased. Thus, if the researcher fails to recognize or properly define a problem in a way that is meaningful to the user, the probability of implementation of the research is limited. In a similar fashion, if the researcher and user disagree on theory, information, analysis, or conclusions, the probability of implementation is also lessened. This general process leads to the first axiom of research utilization.

Axiom 1: Probability of Research Utilization Is Inversely Proportional to Distance Between Researchers and Users of the Research

In other words, research utilization is enhanced through the involvement of the potential users of the research in the entire research process. They should be involved in problem identification, problem definition, theory building, information gathering, information analysis, conclusions, recommendations, and implementation.

In general, the deviation between researcher and user viewpoints is not the result of a deliberate attempt by either to subvert the process; but rather, it is usually a result of other factors. One of these factors is the communication process between researcher and user. If the communication between researcher and user is infrequent and formal, more difficulty in implementation would be expected than if it occurred frequently and on an informal basis. When communications are more frequent and informal, user and researcher are more likely to identify points of deviation as they occur and to correct them before they become irreversible. In addition, there is an ease of information transfer and a greater degree of understanding of the other person's needs and intents.

Axiom 2: Probability of Research Utilization Is Inversely Proportional to Degree of Formality Between Researcher and User

A corollary of this is that the probability of utilization is directly proportional to the level of effective communication between researcher and user. Another factor that may cause a deviation between the researcher and user is differences in the organizational structure of the agencies involved. This is particularly true if the research takes place at a university and the user is a mission-oriented agency, such as a transportation department of a governmental unit. These two types of organizations have very different patterns of operation and structure. In most universities the individual researcher is nearly autonomous in terms of how and what research is conducted. He or she works in an environment where the development of new ideas is the norm and where people are at ease in challenging existing policies and procedures. Also, he or she is accustomed to making decisions on the path the research should take, with little review from others. The university researcher's main objective is to publish.

In a mission-oriented user agency, the organizational pattern is quite different. The individual user of research often is faced with extensive review of his or her efforts and must deal with a large set of constraints and conflicting views. Usually, procedures and policies have been institutionalized, and it is difficult to change them without considerable effort. Thus, the process of implementation of a research result in an agency can be highly complex and, unless the ideas are well sold, it may be easier to do nothing.

Axiom 3: Probability of Research Utilization Increases with the Degree of Understanding that Researcher and User Have of Each Other's Problems and Motivations

It is important that both the researcher and the user understand the environment in which the other works. If this is the case, both can recognize some of the barriers to research implementation that may develop.

BARRIERS TO RESEARCH UTILIZATION

Once a research project has been successfully completed in that the stated objectives have been met and the research has some potential utility, it is useful to look at the process of utilization of the research. The

utilization process includes three basic phases: dissemination, acceptance, and implementation. Dissemination can occur by both formal and informal means. Formal means almost always involve written material, such as project reports, technical papers, or publications, and are likely to have the widest distribution. Informal dissemination can occur in a variety of ways but generally involves person-to-person contact between someone familiar with the research (who may have learned about it through a formal means) and a potential user of the research.

Given that the research has been successfully disseminated, two final steps must take place for implementation to occur. The potential user must accept the ideas presented in the research and must be able to put them into practice. There are many reasons why this may not occur; an effort is made to identify them in the following paragraphs.

The problem has been poorly defined. This often occurs when a problem is defined with limited input from user agencies. Research agency personnel tend to define problems along disciplinary lines and have a goal of advancing levels of knowledge; user agency personnel tend to define problems along policy lines and have a goal of making decisions. Obviously, extensive interaction between the research and user agencies is desirable to define mutually acceptable problem statements.

The research is not valid internally. That is, the research may have been conducted improperly, contain mistakes, or the conclusions drawn improperly. Internal validity is extremely difficult to assess for anyone other than the researcher unless the research is thoroughly and completely documented.

The research may be valid, but the results are not disseminated. Lack of dissemination may be the result of financial, institutional, or other constraints. Also, the research may be disseminated but not in sources readily available or frequently used by its potential users. This problem can occur when research results are published in publications that are not consulted by research users.

The research disseminated may not be relevant to the problems of the potential user. That is, the research does not address or properly articulate a problem as perceived by the potential user. Often this occurs because the potential user agency does not play an active role in the definition of the research problem.

The research is relevant, but the solutions proposed are not feasible for the agency because of legal, institutional, financial, political, or other constraints. The research does not have relevance in a decision context. If the researcher does not distinguish between variables that are subject to manipulation by the user agency and situational variables that are not subject to manipulation, the research results will be of little or no use in a policy context.

The potential to use the research exists, but the user is unwilling to develop this potential for other reasons, such as concerns for its implications to other programs, internal politics, or general resistance to change. The research results are not presented at the proper time. Research results that may have some relevance to a decision may be presented at a point after that decision or irrevocable commitments have been made. In such a case, the research may prove to be counterproductive in that it may cause excessive delay or major conflicts on a particular project.

The research is presented in an unacceptable manner. The research may be used to counter policies of an agency or to generate conflict over agency projects. In this case an adversary situation often develops, with negative results. A positive situation might have otherwise occurred if the research had been presented in a different manner.

The results of the research are not assimilated by the potential user. If research results are to be implemented, they must be assimilated by those who are in a position to facilitate implementation. When results are not presented in the language of the user, it is unlikely that assimilation will occur. Valid, implementable research results are not always presented to persons in policymaking positions. Often the researcher, whether from a university or an agency, simply does not have access to the policymaking process.

The research may not be implemented because of constraints associated with the organizational structures of research agencies and implementation (user) agencies.

Obviously, there are many more possible reasons for the nonimplementation of research results. In an effort to investigate the validity of some of these barriers, a project was initiated and supported by the Urban Mass Transportation Administration (UMTA) through the University Research and Training (URT) program at the University of Wisconsin, Milwaukee.

CHARACTERISTICS OF UNIVERSITY TRANSPORTATION RESEARCH ACTIVITIES

Initially, the intent of the research was to determine, through a sample of UMTA-URT institutions, the extent to which the respective programs had

1. Produced theoretical versus applied research in urban transportation,
2. Disseminated research findings to transportation agencies and other UMTA-URT program institutions,
3. Caused a perceived impact on community transportation problems through the implementation of research results by local agencies, and
4. Involved local community agency personnel in the training or research components of the program.

Major emphasis was to be devoted to the second and third objectives; the remaining two were to be given only cursory examination. As the project progressed, the focus was redirected more toward implementation. Preliminary discussions with URT project directors and a review of some relevant literature revealed that the problem of implementation was poorly understood in the context of transportation research conducted by university researchers.

Implementation has received little formal attention in university-oriented transportation research. The study conducted by the Program of Policy Studies in Science and Technology of the George Washington University (3) recognized the relatively low use of research results as a shortcoming of the then UMTA grant program. Recent work by other transportation researchers has examined implementation in a variety of contexts. The results of these efforts are useful, but they tend to oversimplify the implementation process (4, 5).

Operations researchers and management scientists have recently begun to take a serious look at problems of implementation of operations research models in organizations (1, 6-9). Results are considered implemented if they influence the decision processes of managers. Unfortunately, most of the work has concentrated on implementation within organizations that have also conducted the research; only a few have

addressed the problem of implementation when one organization conducts research targeted for a user organization (7, pp. 53-73). Some of the results of these studies are relevant to research in transportation.

Study Design

The literature review and preliminary discussions with selected URT program directors provided the background for this study. Because of financial and other constraints, a sample of URT programs was drawn for study. In addition, interviews were conducted by telephone with project directors. Each interview required approximately 75 min. A random sample of nine institutions was initially drawn, but two of these were eliminated from the study because of difficulties in contacting the project directors.

The interviews were structured around a questionnaire, which was divided into four parts. The first part contained questions designed to elicit information on the research focus of the respective URT program. Included in this category were questions related to research orientation (theoretical or applied), subject area orientation, individual project size, number of projects, and faculty involvement in the program.

Questions in the second part dealt with research dissemination activities. Here an attempt was made to determine the extent of dissemination of research results, whether the program had an explicit policy for dissemination, the channels used, and the degree to which URT programs disseminated research results to other URT programs.

The third part consisted of questions relative to research implementation. Because of inherent difficulties in obtaining information on implementation, most of the questions in this section attempted to elicit the opinions and attitudes of the respective project directors. In this section, an effort was made to secure information on frequency of implementation of URT research by local transportation agencies, the nature of the impact of URT research efforts on community-related transportation problems broadly conceived, the partial or holistic implementation of research by local agencies, problems and constraints associated with implementation, and how to improve the URT program's effectiveness in providing useful research to transportation agencies.

The fourth set of questions is closely related to the previous set and addresses the degree of transportation agency involvement with the URT programs, whether this involvement was direct or indirect, and opinions regarding the nature of communication between URT program personnel and agency personnel. The interviews were conducted during the summer and fall of 1974. An effort was made to elicit meaningful, accurate responses from the project directors. However, some of the information requested was dependent on the respondent's memory of past events.

Part 1: Research Focus

The response to the question, "What is your estimate of the relative proportions of basic and applied research conducted by the UMTA-URT program at your institution?" was as follows:

Program Number	Basic (%)	Applied (%)
1	10	90
2	20	80
3	10	90
4	30	70
5	0	100
6	25	75
7	80	20
$\bar{X}$	25	75

Several respondents expressed difficulty in distinguishing between basic and applied research. In these situations, basic research was defined as research primarily aimed at advancing knowledge in a discipline or area of inquiry and applied research was defined as research that has practical, specific objectives and practical utility.

The next question was, "What is the subject orientation of this basic and applied research?" Orientation of basic research included demand modeling, experimental psychological models, mode-choice modeling, dial-a-bus, transit rider preferences, and freight handling. Applied research was oriented toward transportation education, mass transit, transportation planning, modal split, modeling transit systems, transit planning, mode choice, and transit system performance. It is interesting to note that research on mode choice was mentioned in both categories. This suggests that a fundamental difference between basic and applied research is one of approach and emphasis rather than subject.

The response to the questions, "Within your program, approximately how many research projects have been undertaken within the last year (or last year of full funding)?" How many of these would you classify as large-sized projects? Medium-sized projects (in terms of financial and manpower commitments)?" was as follows:

Program Number	Number of Projects	Project Size		
		Large	Medium	Small
1	6			6
2	6			6
3	8			8
4	8	1	2	5
5	7	2	1	4
6	5		1	4
7	4			4
$\bar{X}$	6.3			

Therefore, 7 percent of the projects were large, 9 percent were medium, and 84 percent were small in size.

The response to the question, "How many faculty were associated with your URT program during a typical year on a part-time basis? on a full-time basis?" was as follows:

Program Number	Faculty	
	Part-time	Full-time
1	5	
2	10	2
3	2	
4	4	
5	6	
6	4	
7	8	
$\bar{X}$	5.6	

In all but one case, faculty involvement was interdisciplinary. If this sample is representative of all URT programs, interdisciplinary involvement in the research program was achieved. However, such involvement on a project-by-project basis probably does not occur as frequently. Rather, researchers from different

disciplines work on separate projects more often than not. Unfortunately, this contention is unsupported at this time and is a suitable topic for further research.

Part 2: Research Dissemination

The response to the question, "With respect to project research reports, do you have any explicit policy regarding the dissemination of these reports?" was as follows:

Program Number	Response
1	Yes
2	No
3	Yes
4	Yes
5	Yes
6	No
7	No

Of the affirmative responses, two programs had a policy of sending all reports to state and local transportation agencies, advisory committee members, and other interested parties, by using a standard mailing list. Selected reports were then prepared for submission to the National Technical Information Service (NTIS) and journals and for presentation at meetings. The remaining two programs had explicit policies for distribution to state and local agencies and advisory committee members but no set policy regarding other forms of dissemination. This does not mean that these programs or those that responded negatively to this question did not engage in dissemination efforts. Rather, they had no explicit plan of action for dissemination.

The response to the question, "Approximately what percentage of your programs' research is distributed through the following means?" is given below:

Information Distribution	Percent
Program cover (e.g., technical or research reports)	92
NTIS	40
Transportation journals	23
Other journals	1
Oral presentation	
Meetings	17
Local seminars	5
State and local conferences	2

Three of the seven project directors interviewed had considerable difficulty in responding to this question. The percentages reported above are averages for the remaining respondents. Since responses were very similar, the average is a representative measure. The four directors who were able to respond generally seemed intimately knowledgeable about the activities within their respective programs.

In response to the question, "Do you send copies of your research reports to other UMTA-URT programs?" four replied frequently and three said infrequently. This question was an attempt to gain some insight into the frequency of dissemination by this channel. The complement to this question is, "Do you receive research reports from other UMTA programs?" The response pattern was identical to that of the previous question. In virtually all cases, copies of reports either sent or received were few in number. Typically, a program director would send report copies to a few selected friends at other programs.

The next question was, "Which specific research project, conducted under your UMTA program, has attracted the most attention outside of your institution?" This was an open-ended question, and an effort was made to elicit the nature of this attention. Given the dissemination efforts made, the intent of the question was to obtain subjective information on feedback from the sources of interest. In most cases, one or more local transportation agencies expressed interest in a particular project. This usually resulted from the distribution of research reports to these agencies. Occasionally, interest was expressed through requests for copies of the report; these requests were based on recognition of research in NTIS, in a transportation journal, or at meetings. In a few cases, projects gained negative attention, especially when the research addressed controversial transportation problems that were sensitive issues in one or more local agencies.

In response to the question, "Have you experienced any particular problems or constraints with the dissemination of your research findings?" four respondents acknowledged the existence of particular problems, two of whom mentioned cost as a major factor. They were of the opinion that insufficient funds were available to effectively disseminate research results. The other two respondents expressed a concern for problems associated with the effective ways to encourage investigators to finish reports on time.

Answers were varied to the question, "Do you have any suggestions on improving the dissemination of research results to other UMTA programs and to potential users?" The only common element was suggestions to increase the amount of money available for report preparation. One respondent thought that UMTA should distribute the reports. Another respondent saw a need to develop a system to identify potential users better; a logical starting point was the development of better communication between UMTA programs. Still another respondent thought there was a need to recognize that the users of the research are not transit operators but other universities. Thus, it is essential to improve the flow of information from university to university. One way to accomplish this would be to have student-oriented meetings on a regional basis where research would be presented and discussed. Transit operators and other local agency personnel could be invited as panel members. In addition, there was a general feeling that UMTA should have been more consistent and frequent in circulating statements about research progress at funded institutions. Finally, a few respondents thought that the best way to achieve effective dissemination was to involve user agencies in the research process.

Part 3: Research Implementation

In response to the question, "Do you feel that implementation by local agencies of research results emanating from UMTA-URT programs occurs... ," one said occasionally, five said infrequently, and one said very infrequently. Respondents were asked to give some justification for their answers. These can be classified into three types:

1. URT programs engage in small projects that are not that applicable and the research does not address the right problems,
2. Lack of involvement by personnel from local agencies results in low implementation rates (without such involvement it is difficult to establish the communication channels necessary for implementation to occur), and
3. There is a general mistrust of university faculty on the part of many local agency staff.

In response to a question about the impact of the research efforts of UMTA-URT programs, all seven replied that they had a positive impact. Justifications for these responses were given, both in terms of the training and the research components of the program. They may be summarized as follows: First, the programs have had a positive impact because of the training of persons for positions in state and local agencies. During a three-year period, one program accounted for the placement of 15 people in such agencies. In the long run, this is probably an effective means for increasing university-agency communication and agency involvement in research. The products of a small research project are likely to have only short-range impact, if any, whereas the education of persons in transportation is a long-range investment that improves with age. Second, at the local level, the research conducted by some programs generated interest where none would have otherwise existed. Generally, the research may not be implemented, but the exercise of the research effort was worthwhile for the educational process, both within the university and the community.

In response to the question, "To the best of your knowledge, have any of the results of research projects, conducted under your UMTA program been implemented, in whole or in part, by state or local transportation agencies?" three respondents answered affirmatively. Since implementation is sometimes a nebulous term, only relatively clear-cut examples were considered. It is quite possible that implemenation took place without the knowledge of the project director. In all cases, implementation occurred in state and local transportation agencies (both public and private) and planning commissions. Another common element of these implementations concerned the involvement of agency personnel. In all cases, agencies were intimately involved in virtually all phases of the research process. In two of the three cases, the projects involved students who were also employees of local agencies.

Responses to the question, "In your opinion, what are some of the typical problems or constraints associated with the implementation of research results?" were divided into the following categories:

Category	Number
Research is not disseminated	1
Research is not relevant in a policy context	1
Research does not address specific problems	3
Research is not of an applied nature	2
Implementation of research results is not feasible for agencies because of legal, institutional, or financial constraints	4
Research is useful, but the user is unwilling to use it because of its implications to other programs, internal politics, or general resistance to change	4
State and local agencies rely on other agencies for research results	5
Other	2

The numbers recorded above represent the frequency with which each item was selected as a problem or constraint; multiple responses were permitted. Problems in the other category included unwillingness of agency personnel to use the program as a resource for the planning and implementation of research results and difficulties in timing the availability of research results with agency needs.

In response to the question, "What steps do you feel might be taken to improve the UMTA-URT program's effectiveness in providing useful research results to local transportation agencies?" the following suggestions were made by the respondents.

We should attempt to increase the involvement of agencies in research by coordinating university research interests with agency needs. This is not an easy task, but it can be accomplished by first developing a rapport with agency personnel. Effective communication channels must be developed and research needs identified.

The program needs focus. Virtually all resources should be used to upgrade the quality of transit management through education. Research results will not be used unless management is improved.

If universities want to do applied research, much of it will have to be narrow in focus. Researchers will also have to get to know agency personnel well. Transportation agency-university relations are not good. The differences between research and development cause problems since the university is concerned primarily with research and agencies with development. Articulation of the differences between these two activities may be helpful.

Local agencies should be encouraged to use the university as a resource. Considerable expertise exists in many universities, but it is not effectively used by agencies primarily because no mechanism exists for effective communication through cooperative research efforts.

Part 4: Transportation Agency Involvement

All responses to the question, "Are there any state or local transportation agency personnel involved in either the research or training aspects of your program?" were affirmative, and an attempt was made to determine the nature of this involvement. The nature of involvement was divided into two categories, direct and indirect. The results that follow reflect the frequency of response for all seven respondents, not the number of personnel involved.

Involvement	Number
Students take courses	4
Personnel work on research project	
Personnel teach in the program	2
Personnel make presentations in seminars or conferences	3
Members of advisory committee	6
Members of steering committee	5
Consultant	-
Informal information	5

It should be noted that the selection of these categories was the result of initial discussions with project directors not included in the sample. At the time, the items in these two categories were considered to be representative of the majority of agency involvement.

Since the listing of responses to this question does not reflect individual response patterns, it is important to point out that agency personnel were involved directly in only four programs. In addition, if one compares this result with the results of a previous question concerning the actual implementation of the results of a research project, an interesting observation can be made. That is, those programs that reported concrete examples of implemented research results all had agency personnel directly involved in some aspect of their program, typically as part-time students. This observation has important implications for those interested in developing effective mechanisms for implementation. Of related importance is the finding that all agency involvement in the seven programs was the result of efforts initiated by the respective program personnel.

Conclusions

The majority of the research conducted by UMTA-URT programs in this survey was of an applied nature. Yet few examples of implemented research results were identified. Is this due to inherent difficulties with the process of implementation or is it due to the possibility that implementation cannot be examined formally? Is implementation articulated as an explicit process of putting the results of a research project into practice or is the process one that is informal, fragmented, and diverse? Obviously many degrees of variation are associated with implementation, and more research is required to examine some of these.

As mentioned previously, dissemination is an important component of implementation, but its role in the research process must be reexamined. It used to be common (and probably still is) to think that implementation began when a research project ended. The same holds for dissemination. In certain situations, these two activities can play an important role at the end of the research process. However, in terms of the vast majority of urban transportation research, dissemination and implementation must be viewed as important components at all stages of the research process. The results of this research partially support this contention.

MECHANISMS FOR INCREASING THE LEVEL OF RESEARCH IMPLEMENTATION

As a result of this research and a review of relevant literature, certain basic principles, which are appropriate for the researcher interested in implementation, can be stated. These principles are applicable to applied research and serve as guides for anyone interested in increasing the level of research implementation. Different situations require that different subsets of these principles be adhered to in order for implementation to occur.

The first principle states that research results must be timely [i.e., the results (holistic or partial) must be available to the user at the time of the decision]. This decision, whatever its nature, may be viewed as part of a decision chain that incorporates many interlinked decisions. That is, each decision in the sequence is dependent on the previous decision. The conduct of research and the flow of research results should ideally parallel this decision-chain process so that the accumulation of research results coincides with, and has important implications for, each stage of the decision process.

The second principle is concerned with the relevance of the research in a policy context. It may be stated thus: If, in the conduct of applied research, the researcher fails to distinguish between variables that are subject to manipulation by the user and variables that are not, the implementation of results is unlikely. Since implementation often involves a policy change, it is important for the researcher to emphasize policy variables and possible ways in which they may be used to institute changes (1).

The third principle is as follows: To increase the probability of implementation, the researcher must include the user in the definition of the problem stage and other relevant stages of the research process. Too often researchers approach a potential user with completed projects—ones in which the users have had no input. Under these conditions, the user has difficulty relating the results to particular situations since the problem definition may not be acceptable.

The fourth principle is closely related to the third and states that, for implementation to occur, it is imperative that the researcher translate results from the language of academic inquiry into a language that is understandable to the targeted user agency. Although seemingly self-evident, violation of this principle is common, and transportation agency personnel often complain about the technical language used in research reports. As mentioned previously, implementation is dependent on communication, but communication is hampered if the user cannot understand the results or the implications of the results (1).

The fifth principle may be stated as follows: The investigator must conduct research in a responsible, objective fashion. This means that, in the conduct of the research and in the presentation of results, the researcher should attempt to subdue personal values and interests and not engage in advocacy. However, advocacy may be appropriate in making recommendations (which are, of course, based on the research results) to user agencies (1). However, if at all possible, the researcher should avoid situations where advocacy leads to severe conflict with the user agency.

The sixth principle is as follows: Recognize that implementation frequently requires some change in the methods of operations of the implementing agency. Bureaucratic organizations are highly resistant to change, but the researcher may be able to foster and encourage implementation if good rapport has been developed with key agency personnel.

The seventh principle states, The common element underlying successful implementation is communication. That is, effective information transfer is crucial to the implementation process. It is important to recognize and deal with problems that hamper this transfer. "Success is impossible without enlightened users and sponsors who have achieved ownership of the study. Only then will a climate of confidence favor successful implementation" (7, p. 291).

The eighth principle suggests that, in situations where a research project has promising potential for implementation, it is important at the outset of the project to plan implementation along with the research.

These principles are not necessarily all-inclusive, but they have been stated in general terms so that the reader may deduce more specific principles from this basic set. Adherence to these principles and recognition of the various barriers to implementation mentioned previously implies that the researcher be conscious of the process of implementation and the role it plays in the conduct of research. Thus the conduct and implementation of research should be viewed together.

The researcher who is sincerely interested in the implementation of research must engage in more than the mere conduct of research as traditionally defined. He or she must take an active role in the implementation process and be willing and able to develop working relationships with the appropriate agencies. He or she must comprehend the nature of these agencies, their organizational structures, their interests, and the constraints under which agency personnel must operate. He or she must realize that implementation will not always occur despite best efforts. Even though the research may be of a high quality, the elements of the particular situation will be against implementation. Each researcher must know the organizational environment in which he or she operates, change those elements that are susceptible to change, and accept those that are not. In addition, the researcher should conduct responsible research that is timely, and the results should be presented in a constructive manner.

In general, there is a need to examine more thoroughly the process of research implementation in different contexts. This could be accomplished by several intensive case studies of situations in which the management and conduct of research lead to implementation. These case studies could then be used to further articulate the conditions under which the implementation of research results is most probable. A better understanding of the barriers to research implementation awaits further inquiry.

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REFERENCES

1. J. S. Coleman. Policy Research in the Social Sciences. General Learning Corp., 1972.
2. L. J. Haworth. Desirable Initiative and Appropriate Self-Restraint. In Science and Policy Issues (P. J. Piccard, ed.), F. E. Peacock Publishers, Inc., Itasca, IL, 1969.
3. Fostering Urban Transportation Activities in Universities: Recommendations to the Urban Mass Transportation Administration. Program of Policy Studies in Science and Technology, George Washington Univ., Washington, DC, Feb. 1974. NTIS: PB 229 613/5.
4. Management of Research. HRB, Highway Research Record 478, 1973, 33 pp.
5. Getting Research Findings into Practice. NCHRP, Synthesis of Highway Practice 23, 1974, 24 pp.
6. C. W. Churchman and A. H. Schainblatt. The Researcher and the Manager: A Dialectic of Implementation. Management Science, Vol. 11, No. 4, Feb. 1965, pp. B69-B87.
7. R. L. Schultz and D. P. Slevin, eds. Implementing Operations Research/Management Science. American Elsevier Publishing Company, Inc., New York, 1975.
8. A. Harvey. Factors Making for Implementation Success and Failure. Management Science, Vol. 16, No. 6, Feb. 1970, pp. B312-B321.
9. J. B. Quinn and J. A. Mueller. Transferring Research Results to Operations. Harvard Business Rev., Jan.-Feb. 1963, pp. 49-66.

University Management of a Transportation Department's Research Program

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The Transportation Center of the University of Tennessee has entered into an agreement with the Tennessee Department of Transportation to manage a university research program. Six state universities and the University of Tennessee cooperate in the program. The Transportation Center manages the program as part of its research management functions and is the contracting agency. The commissioner of the Tennessee Department of Transportation and a vice president of the university have the final authority in all contractual matters. An office is maintained within the Tennessee Department of Transportation headquarters. The program encompasses research in all modes of transportation and involves many disciplines. An executive committee formulates policy, approves the work program, and approves the awarding of research to the various institutions. A technical advisory council is responsible for all technical aspects of the program. Monitoring teams work closely with the researchers and are responsible for implementation of research findings. The technical aspects of the program include the formulation of research needs through the development of problem statements, which are ranked in the order of need. The highest-ranked problem statements are developed into requests for proposals and forwarded to the cooperating universities, which respond in accordance with their capabilities. The proposals are evaluated, and an institution is selected to conduct the research. Agreements of understanding then are prepared and executed.

The Tennessee Department of Transportation and the University of Tennessee have developed a research management program that is unique in many respects. The program is organized to function basically along the same lines as the National Cooperative Highway Research Program (NCHRP). From its creation in December 1970, the program has grown from a purely highway-oriented research program to one that encompasses all modes of transportation. The first program director was employed in March 1972 as an assistant director of the university's Transportation Center. This research management program initiated the university's Transportation Center and the Tennessee Department of Transportation's full-fledged University Research Program. Under this program, all state universities in Tennessee are able to participate, and the Tennessee Department of Transportation draws on a vast reservoir of knowledge available through these institutions.

In 1951, the Tennessee general assembly passed an enabling act that authorized the department of highways to enter into an agreement with the University of Tennessee for research in highway design, construction, and maintenance. The act was implemented that same year, when the university and the department of highways established the Tennessee Highway Research Program on the Knoxville campus. The program functioned with an