various responsibilities should attend the same technical meeting. The answer is that each has something different to learn and a different need to learn. It is important for them to understand the other's needs. Although it is important for a researcher to have a practical interest in the research, it is far more fruitful to have research that is of interest to others. It is more fruitful to have general interest research and a method of disseminating the results. Technically oriented employees should be encouraged to look beyond the boundaries of their assigned duties and to participate in and comment on projects that might be considered beyond their scope, and, above all, they should be encouraged to critique research and technical data when asked to apply the results to their operations.

SUMMARY

The world's transportation industry has advanced as rapidly as most professional endeavors during the last century. It has also created more than its share of problems. As transportation professionals, we are responsible for delivering all the products and benefits the other professional fields develop; and, therefore, we should make it a point to be understood. In order for others to understand us, we should understand ourselves. An assured method of distribution of transportation-related information is essential. State departments of transportation should be encouraged to maintain highly visible secondary roads departments that actively carry on technical information dissemination and technical support to lower governmental units. Elected officials should recognize the importance of appointed transportation officials' participation in technical conferences and seminars, both as contributors and recipients of the learning process, and should encourage memberships in peer groups for the purposes of information exchange. Leaders in the academic and research areas should invite the user to join in the development of research and resulting data. Digesting research data and technical information and preparing a format for application should be expanded through state departments of transportation and made available to local transportation authorities. Document failures; visibility of failures will allow others to avoid the pitfalls. State agencies and county organizations have an obligation to keep the public informed, and no better method exists than to have participants in public endeavors understand the need and scope of a program. Technical information can and should be digested and edited to serve the public information need. Additional methods of alerting potential users of research data, technical information, and data recovery systems need to be developed. The vast storehouses of transportation information will continue to go untapped if we do not provide the user with a method of reaching that information. There is a great need to provide periodic updating of developed information. A prime example is the public's refusal to accept current highway design standards and the methods used for determining transportation facility capabilities and needs. As transportation experts we may be technically correct, but the public frequently questions the foundation for our recommendations, and more often than not, this creates an impasse situation.

Peer groups, in cooperation with FHWA and state departments of transportation, are capable and should be used to develop and disseminate transportation-related data. The state departments of transportation that do not have designated secondary roads divisions should be encouraged to develop these departments. NACE should continue to seek expansion of its participatory membership. Current cooperative research programs that involve FHWA and TRB should be continued to attain this end.

Measuring the Effectiveness of a Research Program

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The purpose of this paper is to present various traditional techniques used to measure the effectiveness of a research program and to identify steps that can be used to improve its effectiveness. There is considerable variation in how the effectiveness of a research program is rated depending on the subjective point of view of the individual rater. Some of the methods used include benefit/cost, reduced accidents, lives saved, and improved aesthetics with benefits generally exceeding costs by a ratio of nine to one. Some steps identified for improving the effectiveness include (a) agreement on the need for the research and a definition of the problem by all concerned, (b) identification of the wants of administration, (c) literature search for a possible existing solution that can be used, (d) redefinition of the problem, (e) prioritization of research needs, (f) conduct of research in a proper manner with guidance from an advisory panel, (g) involvement of potential users, (h) writing the report in the language of the user, and (i) implementation in a timely manner. The importance of a well-organized program that embodies good management concepts is stressed as the means of providing maximum benefits of research through proper and timely implementation.

Over the last several years, much concern has been expressed on how to get research findings into practice. A significant time lag existed between when the research was completed and when the results were put into use. This was both unnecessary and undesirable. Communication was identified as the major problem contributing to this time lag. Steps were taken by the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and others to close this gap, and these have resulted in more complete and timely research implementation. Large sums of money have been expended annually for research and development activities, which total approximately $350 million by the U.S. Department of Transportation (DOT) of which $50 million was spent by FHWA. The research program has been diversified to cover a wide spectrum of areas.

Efforts have been made to show the benefits of re-

search through the use of benefit/cost relationships. These have been almost always determined by the researcher, and they have been used to determine the effectiveness of a research program and, therefore, to justify its continuation. Other items used as a measure of effectiveness have been reduced accidents, saved lives, improved aesthetics, and improved environment. Reports that discuss research programs all point out that benefits far exceed costs; benefit/cost ratios are approximately 9 to 1.

How do you measure the effectiveness of your research program? How you measure the effectiveness of your program is strongly dependent on your point of view. Our point of view influences our opinions. In addition, our measurement of the effectiveness of a program is dependent on our expectations. If we get more than we expected, then we are pleased; if we get less, then we are displeased. An administrator may view the effectiveness of a research program entirely differently from the researcher. One level of management may be satisfied and another one may not. In general, the measurements of research effectiveness are subjective and are therefore subject to individual feelings, which result in different values from different management levels or disciplines.

Is there an objective method that can be used by everyone that would always produce consistent results? Is it possible to get all individuals who are concerned to look from the same overall broad point of view? Some methods that have been used as a means of measuring effectiveness are the following:

1. The number of reports published in trade magazines,
2. The number of awards,
3. The number of studies implemented,
4. The percentage of studies implemented,
5. The overall benefit/cost ratio,
6. The number of implementation packages,
7. The improvements in operations resulting from research,
8. The percentage of the research results adopted by others through technology transfer, and
9. The size of the research budget.

Some of these would not be very meaningful to a highway or transportation administrator who is primarily concerned with getting problems solved. Research is of little or no value to practitioners unless the results can be applied. This is the only way a return can be obtained for the investment. The major reasons for undertaking research studies are to find solutions to problems or to satisfy some need. At times, research may be undertaken to meet the requirements of some directive or legislative act.

I believe there are things that can be done to produce a common broad point of view and improve effectiveness. This can best be accomplished by following certain steps and obtaining agreement at each step by all those concerned. The first point of agreement must be on the definition of the problem or the need for doing a particular type of research to everyone's satisfaction and understanding. This is the first critical communication relating to a potential research study. If an understanding cannot be reached at this point, then there will be greater disagreement when the study is completed. As a researcher, I must know what the administrator needs so that I can provide a proper solution. It is essential that agreement be reached between all concerned on a well-defined problem or need.

As numerous problems are identified and defined, it soon becomes obvious that some of these problems may already be completely or partially solved. These solutions, if available, must be sought out and matched with the problems. Competent personnel must evaluate the potential solutions to the problem to make certain they are properly matched. There is certainly no need to solve the same problem every few years. Once the available information is evaluated and fit in, the problem statement should be adjusted to everyone's satisfaction so that only the new information required to effect a solution will be sought. It is sometimes very difficult to tell if a solution exists in the literature due to the titles, abstracts, and the manner in which the reports are written. The Federally Coordinated Program (FCP) is very useful in determining what needs to be done in a wide range of topics. The Highway Research Information System (HRIS) is also very valuable. The decisions reached through evaluating available information and redefining needs cannot be taken lightly because they are very critical. They can play a large part in the cost of conducting the research and the time required to obtain the useful results.

Once the problems have been defined, evaluated, and redefined as needed, there are generally more to be solved than finances and staff can support. This necessitates placing the problems in some order of importance or priority by using a procedure or technique to get the most from available funds. Some of the factors that are important and should be considered in establishing priorities are the following:

1. The urgency in finding a solution to the problem: How critical is the problem?
2. The probability of being able to find a solution: What are the chances of success?
3. The potential benefits that can be achieved if a solution is found: What is the expected benefit/cost relationship?

The major reason for priority setting is to minimize the risk involved in conducting the research and maximize the benefits that may come from it.

The next critical step after the research program is established is to obtain the proper solutions through research. One of the keys to successful research is the use of advisory panels to provide guidance during the conduct of the research. The advisory panel must be fully aware of and agree on the statement of the problem and the study objectives. The first step is the preparation of the research proposal by the potential researcher based on the problem statement and study objectives. The proposal should be based on good experimental design procedures and should be realistic in its approach to finding a solution. A good experimental design goes a long way in minimizing unnecessary expenditures and maximizing benefits. The completed proposal should be reviewed by the advisory panel and modified as needed by the researcher prior to beginning the study. Everyone should be in agreement with what the researcher intends in the proposal to avoid confusion and misunderstandings later. A well-thought-out proposal only partially guarantees success, since the qualifications of the researcher conducting the study are also very important. The researcher must have (a) the necessary technical and administrative skills to conduct the study properly and (b) a good understanding of the problem and its relationship to the study objectives. This will help to avoid misdirection. A researcher can be easily misled by some new-found knowledge and concentrate efforts on details unimportant to achieving the objective. Involvement of potential users on the advisory

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