Identification of Effective Means for the Communication of Transportation Technology

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ABSTRACT

The process of technology transfer in highway maintenance was examined with support from FHWA. The analysis of effective methods for the transfer of highway maintenance information and technology was the focus of the study conducted at the University of Wisconsin--Extension and University of Wisconsin--Milwaukee. Analysis of specific techniques covered: circuit riders, conferences or short courses, slide-tapes, state-of-the-art reports, technical notices, trade publications, and add-on notebooks. Recommendations include (a) technology transfer efforts, where possible, by full-time specialists who emphasize face-to-face communication and local feedback; (b) development of a training program for technology transfer specialists who work with state and local officials on highway-related problems; (c) development of a means to improve the quality and user utility of written materials, and to control the amount of information disseminated to local agencies; (d) increased peer-to-peer communication by involving FHWA with local user networks such as professional or trade associations; (e) viewing the market for maintenance information on a segmented basis; and (f) viewing research as an essential component of all stages of the research process.

New ideas and techniques are not adopted spontaneously, but through hard work, trial and error. It is important to recognize this and to make an effort to develop concise, readable information that reaches people who can use it. Concepts and methods that facilitate the process are described. A broad spectrum of skills for effective technology transfer is outlined without offering any magic formula for success.

A study sponsored by FHWA on the process of technology transfer in highway maintenance is summarized (1). Conducted by personnel at the University of Wisconsin--Extension and University of Wisconsin--Milwaukee, the study focused on the analysis of effective methods for the transfer of highway maintenance information technology. The objective was to develop and evaluate a highway maintenance technology transfer program sensitive to both financial and personnel limitations.

The project was organized according to three tasks:

1. A literature review and in-depth inventory of technology transfer methods currently in use, including those in organizations outside the highway maintenance field;
2. An analysis of highway-related agencies and their ability to use research results in highway maintenance. This analysis was performed through phone conversations and in-person discussions with a cross section of personnel in agencies directly involved in highway maintenance; and
3. An in-depth review of several methods of technology transfer to better define the techniques as they would be used in maintenance. This review considered organizational constraints and barriers to technology transfer for the organizations involved. Factors such as the flow of information, ability of the receiving organization to absorb the information, the decision-making process, and the capacity to implement were included.

In order to assess the technology transfer process currently used in highway maintenance, information was collected through contacts with FHWA personnel at national, regional, and divisional levels. In addition, project staff interviewed local highway maintenance personnel, university researchers in the field, and state departments of transportation (DOT) employees, and gathered information from reports and articles dealing with technology transfer both inside and outside the highway maintenance field.

Several models of technology transfer were identified and examined for their potential utility in highway maintenance. As a result of these efforts, a model for transferring highway maintenance technology and the methods to facilitate such a model were outlined. Findings in relation to the identification of effective communication techniques for technology transfer are summarized in this paper.

USER NEEDS AND CAPABILITIES

A major effort of the project was to gain an understanding of the needs and capabilities of highway maintenance personnel when adopting new technologies and procedures. This was accomplished by talking to local personnel in a variety of locations through...
site visits and telephone conversations. The general picture that emerged was that local personnel place a high value on the experience of their peers and rely primarily on word-of-mouth and trade publications as a source of information, rather than formal technical reports. Local road-program managers include both engineers and nonengineers, with few engineers involved in the smaller offices. Typically, the administration of a local road office has a variety of responsibilities ranging from budgeting to actual repair or operation of equipment. These individuals place a high value on their own experiences, as well as on those of their peers in similar situations.

In terms of information sources, many individuals indicated that they do not have the time to read technical materials, that they find the reading hard to understand and generally not useful to their problems. This varies considerably by size of office and by the background of those involved. Large operations headed by individuals with technical backgrounds tend to be more receptive to technical reports than smaller offices headed by nontechnical personnel. However, there is still a degree of resistance even among the larger agencies, and a general skepticism to outside advice at all levels. This does not mean that the local agencies are necessarily resistant to change, there were many instances of creative local solutions to problems such as equipment modification, procedural changes, and a general resourcefulness for making-do with existing material.

The local road offices generally are quite small operations, especially in the more rural areas. These offices are highly visible to the local residents and taxpayers and are obligated to be very cost-conscious in the administration of their programs. Local road personnel tend to be fairly isolated from each other and have fairly limited contact with their peers or similar groups. Very often travel outside the county for conferences or training purposes is severely limited. This is especially true for lower-level personnel.

PRINCIPLES OF EFFECTIVE TECHNOLOGY TRANSFER

Based on previous work, as well as on discussions with local personnel, some general principles of technology transfer for local road personnel were formulated.

• People and organizations are naturally resistant to change;
• Personal contact—the human element—is the most important factor in the spread and adoption of innovation;
• Personal contact, through one-to-one technical assistance and special transfer agents, is expensive in the short run, but immeasurably cost-effective in the long run;
• Effective communication of new ideas and techniques is best done through multiple channels: people, newsletters, case study reports, professional association networks, and publications;
• The experience and endorsement of peers is a very important element in the widespread adoption of innovation and technology; and
• Acceptance of new technology requires time, a lot of work, and risk.

In addition, there are some basic reminders for technology transfer.

1. Support does not automatically follow improvements;
2. Technology transfer is not easy;
3. Communication is everything;
4. The most respected opinion is always that of peers because users do not always believe researchers;
5. An unwilling user can always find a way to make an idea fail;
6. If technology does not improve life, it will not be accepted;
7. Employees will not jeopardize their jobs for new procedures;
8. Researchers prefer to bend problems to suit their methods;
9. Users of research prefer to bend problems to suit their methods;
10. Users always think that the researcher does not understand the problem, and researchers always think that the user does not understand the method; but users are usually right;
11. A written report is never fully understood by anyone but the author;
12. The wrong person always gets the report;
13. A written report longer than 50 pages will never be thoroughly read;
14. Most people in local agencies do not read anything; and
15. Showing and telling is more effective than showing or telling alone.

The principles of technology transfer are further discussed in a separate report, The Technology Transfer Primer (2). Technology transfer is not an easy process and takes considerable effort and persistence to work. Basically the principles outlined here emphasize that the human element is the most critical part of technology transfer, and that ability to understand the needs and capabilities of the users of information is the most critical element of success.

For innovations to be adopted, they need to be communicated to the appropriate users in simple, uncomplicated language. The most effective communication usually involves one-to-one personal contact. This occurs in many ways: (a) through technical assistance given in the field, at meetings, or conferences, and on-the-job; or (b) through the work of a special technology transfer agent or facilitator. The least successful method of communication is the passive dissemination of printed materials. Although printed materials play a role in the dispersion process, their format and the specific way in which they are used is extremely important.

No one technique sufficiently guarantees the adoption of an innovation. Successful technology transfer directly relates to the use of multiple channels of communication. Even one-to-one technical assistance, for instance, depends on the use of printed materials such as original reports, announcements in newsletters, and technical notices in order to bring the innovation to the attention of potential users.

Communication is a two-way process, and an understanding of this is crucial to successful technology transfer. User needs must be considered carefully; therefore, there should be a way to appraise these needs. Just as it is important to have multiple channels for diffusing technology downward from central state and federal agencies, it is also important to exploit multiple techniques in relaying user needs back up to the source. In the case of local highway-maintenance personnel, it is possible that some mechanisms are already in place, but are not sufficiently utilized (local road advisors, technology transfer centers, etc.). It is also important to realize that meeting user needs involves two steps: (a) understanding the problems for which users are seeking solutions and relating them to new or exist-
ing technologies; and (b) identifying outmoded technologies or procedures, and persuading users to adopt more efficient ones.

Even when users are matched with appropriate innovations, users must be receptive to the ideas. There is no way to ensure this, but acceptance can be encouraged. User receptivity is influenced by the style, language, clarity, and authority of the communication. These are controlled by the disseminator. Specific techniques that can be used to enhance technology transfer between local agencies, state, and federal governments are discussed.

**SELECTION OF TECHNIQUES**

As part of the project, several techniques for the effective transfer of new highway maintenance information were identified. This selection was based on review of the literature, discussions with federal, state, and local highway personnel, and previous work in technology transfer. A considerable number of methods are available to transfer technical information to potential users. A majority of the information transfer efforts involves the use of written materials such as reports, books, articles, manuals, study guides, newsletters, and technical briefs.

In a previous project (3), technology transfer techniques were evaluated for cost, immediacy, adaptability, and rigor, as shown in Figure 1a. The first factor, cost, includes the cost of producing and disseminating the information in a specified form. For example, the cost of using a film would include scriptwriting, typing, editing, duplication, and distribution (mailing). The second factor, immediacy, relates to the anticipated date for getting the information distributed, and to the amount of time it takes for a technique to begin distribution of the information. A news release can be prepared and released in a matter of hours, whereas a textbook may be in preparation for many years. A decision must be made as to when the information should be disseminated. The third factor, adaptability, relates to the capacity for necessary updates of the information. If the information on a slide becomes outdated, a new one should be prepared to replace it. On the other hand, as the ideas, illustrations, and photographs become outdated, a textbook needs to be completely revised, edited, and republished. Finally, rigor is a factor that must be considered in selecting a dissemination technique. Rigor relates to how thoroughly information can be disseminated by various techniques. A news release lightly covers a topic that can be approached more rigorously using a workshop format.

A variety of technology transfer techniques were rated according to the four factors (Figures 1b through 1d). The techniques were also rated as to the type of audience they can serve. The prospective audiences receiving the information may include the general public, government (political) officials, government (career) officials, and private-sector groups such as managers, planners, operators, and technicians. Three general audience levels were identified for transportation information.

* Level I--General interest audience that needs a basic understanding of the subject area (e.g., general public, county board members).
* Level II--Management, planning, or operational audience that needs technical information to aid understanding (e.g., director of maintenance, transportation planner); and
* Level III--A highly technically oriented audience that needs specific, detailed information for authoritative reference (e.g., highway engineer).

Each audience type depends on different techniques to receive information, which must be taken into consideration when making the final selection of a dissemination technique. The general public, for example, receives most of its information in the form of mass media (newspapers, conferences, and mailings). On the other hand, technicians rely on technical reports, technical journals, and one-to-one assistance.

**Considerations**

Major factors that influence the choice of technology transfer techniques in highway maintenance include the following:

- Methods must be easily understood by local maintenance personnel, and be concise, relevant to problems, and in simple language;
- Techniques must be at a reasonable cost;
- Techniques should not conflict with current procedures such as the federal highway-state relationship and state-local relationship;
- Techniques should not place an undue burden on federal or state officials for the dissemination of materials;
- Techniques should maximize the use of peers as a means to relay information;
- Techniques selected for further exploration should include a mixture of written, oral, and visual techniques;
- Techniques should include a screening process to ensure that the amount of irrelevant or unusable materials is kept to a minimum, which will help maintain credibility, as well as keep costs down;
- Rigor is not overly important; techniques should emphasize results and experience of others, and rigor can be documented elsewhere in technical reports not widely disseminated;
- Moderate changes may be necessary in the material over time; however, there does not appear to be a need to accommodate frequent changes;
- Immediacy is not an important consideration; a reasonable wait is acceptable if it results in higher quality material; and
- Materials should be easily recognized and not buried among other things.

It is important to recognize the capabilities of local highway personnel to absorb and understand technical information and to work within the constraints of the agencies that develop such material. Accordingly, technical material should be concise, relevant, and credible. Dissemination should be at a reasonable cost and should fit within the existing relationship between federal, state, and local highway agencies. Of the four factors already identified on selection of dissemination techniques (cost, rigor, immediacy, and adaptability), cost and rigor were believed the most important. Immediacy and adaptability were not believed major constraints because almost all dissemination methods examined can be developed with a sufficient amount of time and effort to meet the needs of highway maintenance personnel.

A set of techniques was identified using the selection guide in Figure 1. These techniques are characterized as moderate- to low-cost, not overly rigorous, and, therefore, not too complex for the type of audiences in highway maintenance (see Tables 1 and 2). Note that no one technique is likely to meet all needs, and that in many situations a combination of techniques should be used.

Note, also, that the characteristics of the people performing technology transfer in highway maintenance include...
are as important as the techniques they use. A positive, helping attitude, as well as a clear understanding of the problems local agencies face is essential for any technique to be effective. Local personnel in highways often rely heavily on their peers to get information and believe that outsiders do not understand their problems. This means that the people selected for technology transfer have to be carefully chosen, and it implies the need to ensure that research problems are defined with a clear understanding of local needs and constraints.

Based on Tables 1 and 2, and on discussions with local personnel, the following techniques appeared to be a promising means of transferring information on transportation innovation:

1. Circuit rider,
2. Conference or short course,
3. Slide and tape or transparency and tape,
4. State-of-the-art reports,
5. Technical notice,
6. Trade publications, and
7. Add-on notebooks.
The Department of Agriculture adopted the term for a professional resource person assisting small, rural communities to deal with the complexity of operating local government.

In technology transfer the term is used to describe a similar system in which a professional helps to spread innovation. The ideal circuit rider maintains a traveling road show. Whether working out of

### Circuit Riders

Circuit rider is a nineteenth century American term for a pioneer preacher assigned to a horseback circuit or route on the frontier. He offered religious services to settlements without a regular preacher.

### INFORMATION TRANSFER TECHNIQUES

![FIGURE 1 (continued)](image-url)
TABLE 1 Applicable Techniques for General Audience in Highway Maintenance

<table>
<thead>
<tr>
<th>Low to Moderate Cost</th>
<th>Not Overly Rigorous</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course</td>
<td>Motion picture (16 mm)</td>
<td>Brochure</td>
</tr>
<tr>
<td>News release</td>
<td>State-of-the-art report</td>
<td>Discussion group</td>
</tr>
<tr>
<td>Workshop</td>
<td>Motion picture (8 mm)</td>
<td>Newsletter</td>
</tr>
<tr>
<td></td>
<td>Newsletter</td>
<td>Seminar</td>
</tr>
</tbody>
</table>
|                     | Slides              | Slides-
|                     | Slide-tape         | Telephone hot line |
|                     |                     | Transparencies |

Note: Personnel include engineers and supervisors.

TABLE 2 Applicable Techniques for Managerial Planning and Operating Personnel in Highway Maintenance

<table>
<thead>
<tr>
<th>Low to Moderate Cost</th>
<th>Not Overly Rigorous</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference</td>
<td>Add-on notebooks</td>
<td>Brochure</td>
</tr>
<tr>
<td>Journal article</td>
<td></td>
<td>Discussion group</td>
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<tr>
<td>Workshop</td>
<td></td>
<td>Microforms</td>
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<tr>
<td></td>
<td>Motion picture (8 mm)</td>
<td>Newsletter</td>
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<td>Newsletter</td>
<td>News release</td>
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<tr>
<td></td>
<td>Seminar</td>
<td>Seminar</td>
</tr>
</tbody>
</table>
|                     | Slides              | Slides-
|                     | Slide-tape         | Slide-tape |
|                     | State-of-the-art report | State-of-the-art report |
|                     | Technical notice    | Technical notice |
|                     | Trade publication   | Trade publication |
|                     | Transparencies      | Transparencies |

Note: Personnel include engineers and supervisors.

The most persuasive, intensive aids are slide-tapes and other audiovisual aids. Communication research indicates that people remember 10 percent of what they read, 20 percent of what they hear, 30 percent of what they see, and 50 percent of what they hear and see. In this respect, the benefits of using audiovisual aids in the transmission of technical information are obvious.

There are many types of visual aids available to conference speakers, training leaders, circuit riders, and technology transfer specialists. Some types include the following: slide-tapes, transparency-tapes, videotapes, filmstrips, 8 mm and 16 mm films, flip charts, handouts, chalkboards, easel pads, and overhead transparencies.
Technical Notices and Newsletters

A technical notice is a short (one to three pages) summary of an innovation that includes a brief description of the innovation and its advantages, as well as a contact name, address, and telephone number for further information. The technical notice is crucial to the dissemination process because it represents the first link between central research and administrative units and local and regional technology transfer agents and users. The technical notice attracts the attention of potential customers for an innovation, without detailed descriptions. The notice is a tool to build awareness among potential users. It should read like a news release rather than a document abstract. Language should be free from jargon and style, simple and concise.

The purpose of the notice is to attract attention, so it should be as graphically distinctive as possible. As with a newsletter, the logo should be eye-catching, so that the receiver learns to identify it with the sending agency. Headlines should be positive and specific.

Besides providing the name, address, and telephone number of a specific contact person, an ideal technical notice includes a detachable mailer or coupon encouraging the reader to find out more. The notice should be as specific as possible on what further information is available. For example, if related slide-tape, videotape or film productions are available, they should be cited.

Technical notices should be distributed to a variety of people including potential users, state transportation officials, appropriate trade publications, editors of relevant newsletters, and transportation researchers. Extra copies should be made available for personal distribution by local technology transfer agents or circuit riders.

Advantages of the well-produced technical notice are obvious:

1. Interest is generated without obscuring the message with irrelevant details. This feature is especially important when dealing with an audience that is not particularly receptive to change;
2. There are a variety of uses including announcing new technical developments, updating existing procedures or products, announcing upcoming training courses, and directing readers to relevant trade journal articles, audiovisual presentations, or new books or reports;
3. It allows easy insertion into a trade magazine or newsletter;
4. It is a cost-effective way to reach a large number of people with a concise, concrete message; and
5. A more selective audience can be identified for longer, more detailed reports through the use of a detachable request for further information.

However, technical notices can pose some difficulty for the sending agency. Disadvantages are as follows:

1. Special writing skills are required. The clever headline followed by a concise summary is a difficult format, especially when the raw material is lengthy technical report;
2. Extensive mailing lists are required, and must be updated continuously in order to be effective; and
3. The brevity increases the risk of loss through desktop shuffle.

State-of-the-Art Reports

State-of-the-art reports collect information on the latest research and practices on a particular topic. Like all printed communication, they must be written at the level of interest or comprehension of their audience. Therefore, a state-of-the-art report designed for university researchers differs greatly in style and content from that designed for local personnel. However, reports addressed to researchers should be translated out of technical jargon.

State-of-the-art reports differ from technical reports and notices because they do not emerge naturally from ongoing research. They are produced through some sort of special mandate. For example, the American Association of State Highway and Transportation Officials, through the mechanism of the National Cooperative Highway Research Program, has authorized the Transportation Research Board to undertake a continuing project to search out and synthesize successful research applications for highway administrators and engineers. The result is the Synthesis of Highway Practice series. Although this series may be a useful reference source for state transportation engineers, it has little use on the local level. At that level state-of-the-art reports will be quite different, with step-by-step directions for a very specific process, simple language, and easily understood illustrations.

Trade Publications

Discussions with local highway personnel show that industry magazines and trade publications are important sources of information for practitioners in the field. In addition, a survey of local maintenance officials conducted by the Cornell Local Roads Program in 1982, asked which resources were relied on the most for keeping up-to-date on new developments. Respondents could indicate any number of sources, but were asked to circle only the most important source of information. Industry magazines were indicated by 184 of the 259 respondents (71 percent). In addition, 33 people (13 percent) considered the industry magazines the most helpful resource. The only resources considered more important were direct communication with colleagues (50 or 19 percent), and conferences and training courses (49 or 19 percent)

Trade publications take a variety of forms and include widely distributed national magazines such as Better Roads, Public Works, and American City and County; regional publications such as Western Builder, and Wisconsin Counties; and association newsletters such as those published by the American Road and Transportation Builders Association, and the Wisconsin County Highway Commissioners' and Committee Members' Association.

It is important to find out exactly which trade magazines are read by local personnel. When the most influential publications are identified, format and
content should be analyzed. Technical notices describing innovative technologies and techniques should then be targeted by topic to the appropriate publication. The material could then be incorporated into the magazine for wide distribution.

Add-On Notebooks

Add-on notebooks are three-ring binders that serve as convenient, permanent, easily updated reference files for various kinds of technical communications. They are often used to update manuals with new information or to keep rapidly changing information current and complete. Add-on notebooks complement previous techniques because they can be used to organize material. For example, technical notices can be categorized and filed in a notebook for ready reference and use.

Each of the written communication techniques discussed here will eventually become outdated. The only way to update trade publication articles is to publish new articles and hope that they reach the appropriate readers. However, both technical notices and state-of-the-art reports are easily adapted to the add-on notebook format if indexes and tables of contents are supplied periodically to help organize the material.

RECOMMENDATIONS FOR IMPROVED TECHNOLOGY TRANSFER

Suggestions in this paper for effective techniques for highway technology transfer derive from a survey of existing technology transfer methods and an evaluation of these methods for their suitability for both information users and researchers in highway maintenance. Recommendations were made based on the analysis of information collected in this project.

Wherever possible, full-time technology transfer specialists should be designated to perform technology transfer activities. If feasible, these individuals should function as circuit riders to disseminate information on a face-to-face basis as much as possible. The specialists should be trained to methods to obtain feedback from users on the effectiveness of the information transferred. Selected individuals need to be outgoing and capable of building credibility with local agencies.

A training program should be developed for technology transfer specialists working with state and local officials on highway-related problems. The purpose of this program is to provide instruction in the basic principles of technology transfer and to demonstrate how to conduct and manage successful technology transfer activities. The course should be 1 to 3 days long and should include the following topics: definitions, technology transfer process, factors affecting adoption of innovations, dissemination techniques, technical assistance procedures, case studies, and examples.

The quality and usefulness of written materials need improvement, and the amount of information disseminated to local agencies needs to be controlled. In order to increase the readability and effectiveness of highway research results, the following are recommended:

1. A research review committee should be established to select materials and projects for wide-spread distribution. This committee should operate at the national level and include representatives of local government, state DOTs, and users of research as major participants. When the committee has selected projects, the material is then disseminated directly to local users as outlined below, without the need to be reviewed further at intermediate state or federal levels. State DOTs and FHWA regional- and division-level offices could continue to participate in the technology transfer network as in the past, but with a lessened review function. This recommendation aims to reduce the multiple reviews that reports sometimes go through. The committee should have some flexibility as to the types of dissemination techniques to be used, depending on the particular needs of the audience.

2. For each project selected for widespread dissemination, a short (two to three pages maximum) technical summary should be prepared. This summary should be written in a journalistic style so that it can be easily used in trade publications, newsletters, and magazines. The summary should emphasize the benefits of the technique, its easy use, observable results, and costs. If possible, the summary should also discuss peer group experience in different locations. The summary should also be formatted for insertion in a three-ring binder under a given category.

3. Technical summaries should be distributed directly to the state, county, and municipal organizations that hold meetings for state and local officials responsible for construction, maintenance, and operation of roads and streets. Distribution should also include the academic and industrial community, particularly the rural technical assistance program (RTAP) centers, and professional and trade publications as appropriate. Follow-up should determine how these materials have been used.

4. A series of briefs should be developed, which would utilize technical summaries in three-ring binders as described earlier and include state-of-the-art or state-of-the-practice summaries in areas in which there is no active research. The briefs should be distributed directly to interested local supervisors, engineers, and administrators. As material accumulates, separate state-of-the-art reports can be repackage the briefs series.

5. Slide-tape presentations should also be prepared on key studies describing the project and its potential benefits. These presentations should be designed for use at state DOT district offices, local agencies, and state or regional conferences, as appropriate.

Efforts should be made to increase the opportunity for face-to-face communication to improve the dissemination of new techniques for highway information. Face-to-face communication among peers remains the most effective and most credible technique for communication. Such contact can occur through increased participation in local and state association meetings. Participation in local and regional meetings by state and federal personnel should be encouraged and backup materials should be provided for effective presentations.

There is a need to view the market for transportation information on a segmented basis. The needs of different users vary greatly, and, whenever possible, these needs should be addressed separately. Research can be directed toward other researchers (basic research) or be applied in the field. Needs of rural and urban areas, snow, and sunny climates, skilled and unskilled labor should all be different. Before dissemination materials are prepared, the potential audience for that material should be identified and audience needs should be the basis for dissemination strategy.

Finally, there is a need for agencies involved in transportation to recognize more fully the importance and complexity of technology transfer as re
search programs are developed and implemented. Utilization of research should be viewed as an important component of all stages of the research process. Research should, therefore, be conducted with a clear understanding of who the potential users of research are, as well as their needs. Ideally such research should involve potential users in problem definitions, in the development of work statements, and in the conduct of research. Expanded mechanisms for greater user involvement in research should be developed and tested. Results of research should be field-tested and disseminated in accordance with a comprehensive plan for dissemination that recognizes the ability of potential users to understand the information. In summary, efforts should be made to obtain feedback from users and to update the results to keep them current.

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