are geography, user needs, mission, and technology areas. The mission division is a traditional mission agency notion (i.e., DOT laboratories respond to transportation needs and DOE laboratories respond to energy needs). Obviously, inputs are made to the system through the mission division, but, for technology transfer purposes, they may not represent the best entry because other agencies often have technical activities similar to those found in a mission agency.

Within the FLC is a technology area coordination system for contact for technological application coordination (CONTAC) that attempts to cut a cross section of the laboratories in terms of technology areas. Many technology areas currently identified with certain laboratories can be seen in Table 1. A resource directory is available that allows a user, whether public or private, to find out what is generally available in the laboratory system. Interestingly, no directory addresses the total spectrum of capabilities within the laboratories.

The user-needs division is an input mechanism that attempts to make the federal laboratory system aware of the needs of potential users. One mechanism currently used is a monthly FLC newsletter that makes user requirements known to consortium representatives. This and other planned efforts are combined with program linkages to the public sector implemented through the Intergovernmental Science Program at the National Science Foundation (NSF).

The geographical division is a regional network designed to aid state and local governments more directly (Figure 2). Within each FLC region, the laboratories maintain a close working relationship with the existing NSF intergovernmental activities previously mentioned. These regional activities form a technology-transfer network. If a person in a state or local government has a problem, he or she can interact with someone locally and not become too involved in the national network unless there is some overriding reason that makes it necessary to do so.

CONCLUSION

To use all available resources to solve national problems, there must be greater interaction and communication between the federal laboratory system and local levels of government, as well as with the private sector. The federal laboratory system is an important public investment, and only time and dedicated effort will tell if this system, when viewed as a national science and technology delivery system, will be successful.

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Federal and State Programs and Activities for Transportation Technology Transfer

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This paper describes some of the technology-transfer programs and activities within the U.S. Department of Transportation (particularly those of the Federal Highway Administration) and state transportation and highway agencies. The U.S. Department of Transportation programs highlighted include the Technology Sharing Division and Transportation Research Information Service of the Office of the Secretary, Transportation Systems Center activities, Urban Mass Transportation Administration planning systems, and major research, development, and demonstration programs. The technology-transfer programs of the Federal Highway Administration described include details on research implementation, experimental projects, demonstration projects, and National Highway Institute programs and the internal-technology-transfer delivery system established to conduct this function. Some of the principles and successful approaches being used by state highway and transportation agencies to conduct effective technology-transfer programs are also described.

From its beginnings, the U.S. Department of Transportation (DOT) has devoted major attempts to technical assistance with associated dissemination of results of research, development, and demonstration programs to states and cities. Most directly concerned with the subject of technology transfer are the specific research, development, and demonstration programs conducted in the Office of the Secretary and within the operating administrations. I will not attempt to go into detail on the many technology-transfer activities of DOT; however, I would like to highlight some of the more important ones.

OFFICE OF THE SECRETARY

The Office of the Secretary (OST) Technology Sharing Division is active in the technology-transfer efforts on a governmentwide basis. The efforts of Al Linhares, in particular, have been significant in the organizational and ongoing efforts of the Urban Consortium Transportation Task Force and the Committee on Domestic Technology Transfer, a coordinating body for civilian federal agencies, which is sponsored by the Federal Coordinating Council for Science, Engineering, and Technology. In addition, a Transportation Research Information Services (TRIS) network is being developed in OST to link transportation information service centers in a system to provide one-stop service of the information needs of transportation-oriented technologists and planners. Individual DOT-sponsored information systems, such as the Highway Research Information Service

(HRIS), are the building blocks for the TRIS network.

RESEARCH AND SPECIAL PROGRAMS DIRECTORATE

The new Research and Special Programs Directorate includes the Transportation Systems Center (TSC) in Cambridge, Massachusetts, a major research arm of the DOT, which has a large role in the exchange of information with states and cities. TSC's basic roles in technology transfer are (a) packaging and disseminating research results, (b) conducting training courses and seminars, and (c) giving technical focus to OST-supported activities in the transfer process. The center is also responsible for maintaining and updating the TRIS file to ensure that these files are available to the state and local community.

The directorate also includes the following:

1. The Transportation Safety Institute in Oklahoma City, which provides safety training courses for state and local government and industry respresentatives;
2. The Materials Transportation Bureau, which provides training in accident investigations, hazardous materials safety, and inspection techniques for state and industry representatives; and
3. The Universities Research Program, which is designed to focus universities' expertise and knowledge on the solutions of pressing national transportation problems.

URBAN MASS TRANSPORTATION ADMINISTRATION

Technology transfer has always been inherent in the Urban Mass Transportation Administration's (UMTA's) operations because of its large grant and assistance program.

The UMTA Urban Transportation Planning System (UTPS), part of a joint UMTA-Federal Highway Administration(FHWA) developed multimodal software planning package, provides state and local planners with the latest technology in transit planning tools to assist them in solving their local transit problems.

UMTA's major research and development programs cover subjects such as bus and paratransit, rail transit, new systems and automation, safety and product qualification, and socioeconomic factors. The delivery system for using the technology developed in these programs is built-in and supported by UMTA operating programs. For example, the light rail program is designed to provide guidelines and standards for low-cost urban light rail vehicles and systems. The Office of Research and Development is generally responsible for the research and development and initial field test and evaluation of the developed hardware. UMTA's demonstration programs are then used to fund, promote, and obtain widespread use of the new technology on a trial basis. As part of its training program, UMTA is developing resident courses for transit system managers.

UMTA's dissemination activities are designed to ensure that program results are documented and readily available and that the information generated is in a form readily assimilated by the transportation community.

FEDERAL RAILROAD ADMINISTRATION

The Federal Railroad Administration's (FRA's) current technology-transfer efforts are oriented toward the near and intermediate requirements of railroads, railroad equipment suppliers, state and local governments, and areawide planning agencies.

The major test facilities for FRA research and development are at the DOT's Transportation Test Center near Pueblo, Colorado.

NATIONAL HIGHWAY TRANSPORTATION SAFETY ADMINISTRATION

The research and development and technology-sharing efforts of the National Highway Transportation Safety Administration (NHTSA) are oriented toward three major program priorities:

1. Safer vehicles for occupants,
2. Alcohol countermeasures, and
3. More effective vehicle standards.

Technology-sharing efforts are fostered by governors' highway safety representatives, national advisory groups, demonstration programs, information services, and training programs. NHTSA offers a resident course in Highway Safety Program Management at the Transportation Safety Institute.

FHWA

Technology transfer is a major program element in FHWA, and many believe it is the key to the continuous success of the highway program. One of the most significant points FHWA has recognized is that technology transfer can no longer be left to chance, goodwill, or coincidence. It must be organized, maintained, and managed. Accordingly, all levels of the FHWA have a role in FHWA's technology-transfer activities. In Washington, at the top-management level, an executive committee on application of improved technology has been established to coordinate the overall agency technology-transfer activities. At the middle-management level, an interoffice review group has been established in headquarters for the four Washington-based programs involved in technology transfer to coordinate their activities and to prevent duplication of effort.

These four programs are

1. The Implementation Program in the Office of Research and Development,
2. The Experimental Projects Program in the Office of Engineering and Traffic Operations,
3. The educational program of the National Highway Institute, and
4. The Demonstration Projects Program in FHWA's Region 15.

The Implementation Program includes full-time professional engineers, known as implementation managers, who are responsible for translating research into a form suitable for practice. The translation includes appropriate field testing and evaluation and the development of operating tools or user packages generally consisting of some combination of field orders, manuals, handbooks, specifications, films, training materials, computer software packages, and prototype hardware necessary for successful technology transfer. The implementation managers establish and maintain relationships with appropriate FHWA research and Washington office personnel, who together work as a team during the transition period when a product moves from research to practice.

The Experimental Projects Program provides the means by which field tests and evaluation of new highway construction materials, equipment, and processes that have a high priority for application can be achieved.

Through the Demonstration Projects Program, opportunity is provided for states to observe actual field demonstrations, which show the practical application of new technology resulting from research and development. The National Highway Institute programs provide the mechanisms for necessary educational and training programs that are essential to the adoption of new and improved technology.

In the FHWA field organization, regional technology-transfer coordinators have been established as the focal point for regional efforts to promote and stimulate the potential application of appropriate new technology in their regions. At the state level, each FHWA division office has given designated individuals the responsibility for technology-transfer activities similar to that at the regional level. The FHWA division offices provide the primary focal point for FHWA efforts in reaching states, cities, counties, and other local users. In fiscal year 1976, to emphasize its importance within the agency, FHWA designated technology transfer as a major program emphasis area. This served not only to stimulate technology-transfer activities within FHWA, but to firm up the necessary delivery mechanisms required for a successful activity.

STATE HIGHWAY AND TRANSPORTATION AGENCIES

The American Association of State Highway and Transportation Officials (AASHTO) Special Committee on Utilization of Research, in a study completed in 1968, highlights an unnecessary and undesirable lag between completion of research and the utilization of findings from highway transportation research. The committee concluded that the lag was caused by a communication gap or missing link between research and operations. Active state technology-transfer programs start with the objective of bridging this gap as a foundation of its efforts. The AASHTO committee also indicated that the gap might be bridged by a new breed of professional generalists. Today, we would probably identify this generalist as a technology-transfer coordinator.

A practice of involving operational personnel, who are the potential users in the decision-making process for the technology under consideration, is the most commonly used mechanism in states that have active technology-transfer programs. This involvement starts with the screening process and proceeds right through whatever experiments or trials are deemed appropriate, to the point where a decision can be made to accept (even partially) or reject. In many states the initial involvement starts with research and operations representation on a research, implementation, advisory, or user committee, or some ad hoc group that does not have a specific title. Quarterly (or periodic) and final meetings are normally part of the monitoring phase prior to final decisions for those items that require field trials and evaluations. When the decision is made to accept, classroom training, workshops, or seminars have key roles in the way states attempt to achieve widespread application in the desired manner.

One effective technique used by a state to involve operating personnel early in the review process for technology developed elsewhere is to screen the projected outputs of FHWA implementation efforts with the FHWA division technology-transfer coordinator to determine which items might have the greatest application for that state. State functional specialists are then selected to monitor designated items. This technique has the advantage of providing lead time if additional resources are required, spreading the work load, and providing a management framework for the large number of items under consideration at any one time.

Most states conduct excellent in-house training by using their own personnel. There is substantial technology, however, that requires assistance by outside resources. The FHWA National Highway Institute programs are active in this area. In addition, states have working arrangements with their own state universities and colleges to provide supplemental training without going outside the state. This is particularly important in view of current restrictions on out-of-state travel. In some cases this training has been accomplished by using material produced by FHWA, which is available free of charge. Carrying the training process one step further, some states have programs that allow city and county personnel to sit in and receive training along with state personnel.

An effective transfer mechanism, which is increasing in popularity, is that of states allowing their personnel to take active roles in providing training outside their boundaries. Good examples of this are the participation of personnel from

1. Wyoming—computerized bridge rating system,
2. California—air and water quality,
3. Texas—safety programming, and
4. New York—wave equation.

Also, state efforts in the preparation of implementation packages and other user-oriented materials have increased substantially during the last few years. Good examples of the activity are

1. Georgia—Portland cement concrete pavement finishing,
2. North Carolina—production management for maintenance,
3. Texas—quick load test,
4. California—water quality manuals,
5. Oregon—keyed rip-rap film,
6. New Jersey—Stimsonite 99 slide tape,
7. Utah—preformed inductive loops, and
8. Nevada—finishing of concrete structures.

In some states, effective use has been made of the implementation line item on activities, such as preparation of implementation packages and visual aids, conduct of seminars, workshops and demonstrations, and evaluation of experimental projects.

Most states have instituted activities, such as informal one-page flyers or newsletters, short unofficial films or video tapes, and slide packages, for field distribution. Some states prepare annual research implementation accomplishment reports. These activities supplement other more formal practices, such as issuance of directives or changes in specifications or standards.

A very significant technology-transfer activity involves the substantial number of new proprietary products that are introduced annually for application on the highway system. A cooperative AASHTO-FHWA effort is to consolidate all test and evaluation information from the states testing those products and to issue the publication Special Product Evaluation List (SPEL) (1).

Complementing the more formal technology-transfer activities are national and regional groups, which meet periodically to exchange information on new technology. For example, the states in Region 3 have held periodic meetings for the last few years on regional bridge deck deterioration and exchanged their experience with potential solutions. Joint state-FHWA regional meet-

ings over the years have included technology transfer as major items on their agendas. Probably the most important information groups are the committees supported by larger organizations such as AASHTO and TRB. All these informal group activities provide the essential communication networks that fill the gaps in information exchange left undone by the more formal efforts. In accomplishing the described state activities, federal resources from programs such as the federal-aid, demonstration, National Highway Institute, implementation, and highway planning and research programs, have been used in addition to state funds and personnel.

CONCLUSION

Technology transfer is not new: What is new is the emphasis to accelerate the process, to shorten the time it takes for usable research to become accepted practice. What is new is the emphasis to create the multiplier effect from federal to state, from state to state, and from state to city to county. These are the key objectives. I believe the programs and activities discussed provide evidence that, during the last few years, great strides have been made by the highway community in bridging the gap between research and practice. The foundation is now set for further improvements, and to do this requires that the momentum of our current efforts be continued.

REFERENCE

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Local Government Technology Transfer

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This paper describes the initiation and progress of a university-based technical-assistance program for local governments. Initially funded by the National Science Foundation, the program began with a statewide needs-assessment program that had input from both municipal and county officials via five workshops. Both technical problem areas and barriers to technology were identified and categorized. The program has operated for more than three years, providing technical assistance via quick response to individual requests, technical workshops, and major research and development projects, which use faculty and students. Examples of technology-transfer programs and some assessment of their credibility and impact are presented. Recommendations for newly emerging programs are summarized: (a) an attitude of sharing with other organizations is essential, (b) local credibility is the single most important factor, and (c) work should be on user-selected problems. Inputs for future policies and programs are presented: (a) there is a significant need for a nonagricultural extension service, (b) to implement federal research there must be a final linkage at the local level, (c) definition for federal research must begin at the local level, and (d) federal agencies should give higher priority to implementation.

The Center for Local Government Technology is a public-service program of Oklahoma State University. It provides assistance to city and county governments in the implementation of engineering and management technology in order to improve the productivity of delivery of local services. Oklahoma is a relatively young and rural state. Local government bodies consist of 77 counties and approximately 982 incorporated villages, towns, and cities. Income is generated from agriculture (40 percent) and petroleum and manufacturing (splitting the remaining 60 percent).

The program began with a National Science Foundation (NSF) grant to conduct a statewide assessment of local needs and to develop a program that might best meet these needs. A series of five district meetings was held with county extension directors and other local personnel from the Cooperative Extension Service. The purpose of these meetings was to establish personal liaison between the program leaders (Joe H. Mize, Charlie A. Burns, and myself) and to explain how the center would relate to the established extension program. Next, a series of five workshops was held in these districts to meet with government officials from local municipal and county governments. These workshops established problem areas and technical needs, current resources, and barriers to the use of technology as a problem-solving tool. Technical problem areas were grouped into three major categories, which were divided into subgroupings as indicated below:

1. Equipment management—specifications preparation and selection, maintenance, and replacement decisions;
2. Public works management—planning of road and bridge systems for rural counties, street maintenance, planning and operation of solid waste systems and water and sewer systems, and calculation of the costs of public services; and
3. Manpower management—job descriptions, manpower scheduling, determination of optimal crew size, incentive plans, manpower training and retention, and functional organization.

During these meetings, six major barriers to technology transfer were identified:

1. Unawareness of information,
2. Lack of trained personnel,
3. Inability of experts to be understood,
4. Inadequate finances,
5. Lack of confidence in technical information, and
6. Resistance by operating personnel.

Many potential resource agencies and organizations were identified, but, on closer questioning, almost none provided the final link to the use of problem-solving technology. Most officials from smaller units of government were generally unaware of any potential resources.