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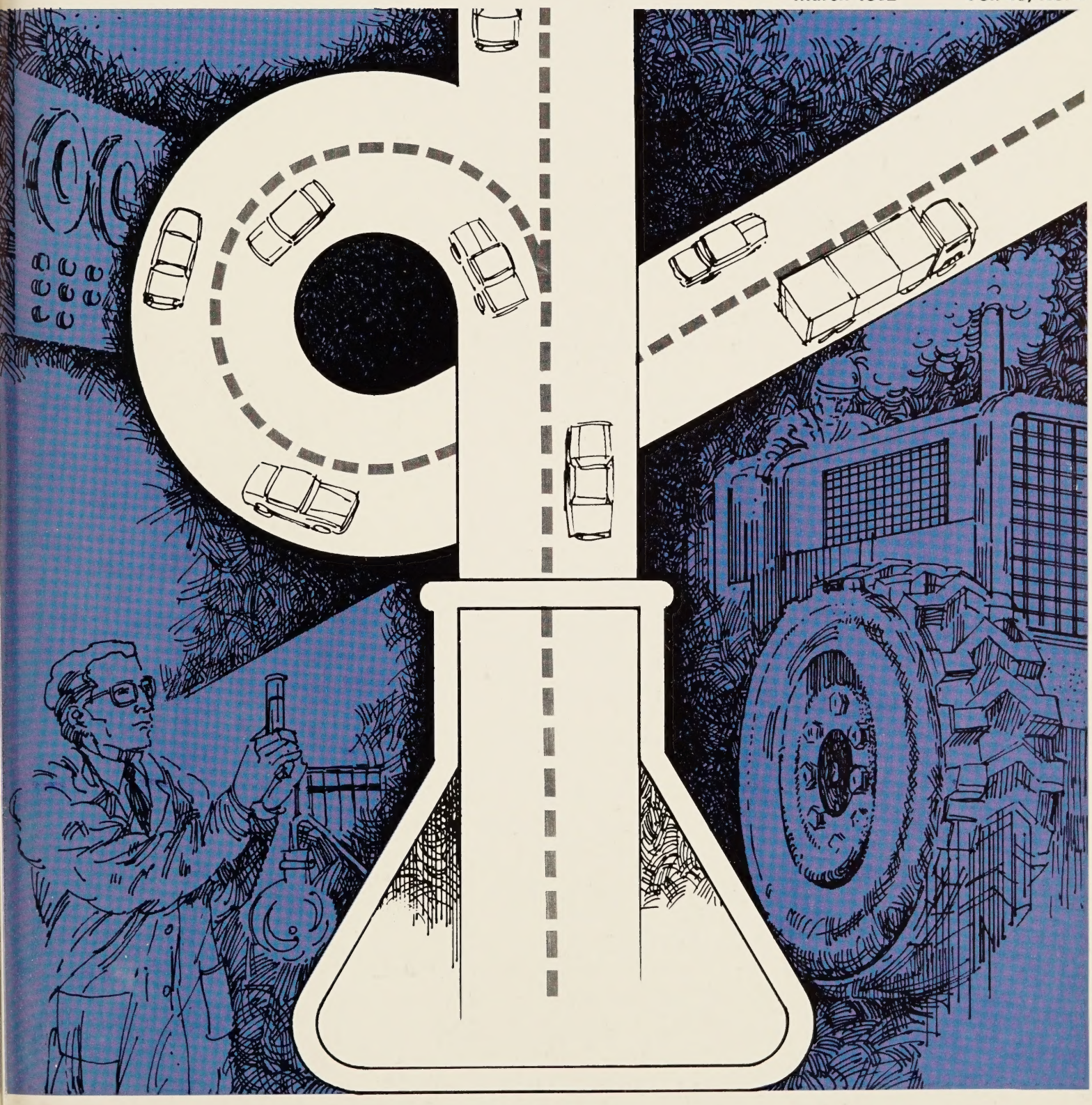

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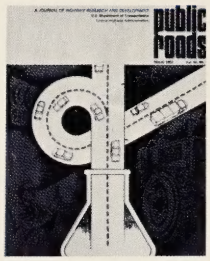

COVER:
FHWA's Technology Transfer Program concentrates on bridging research, development, and application.

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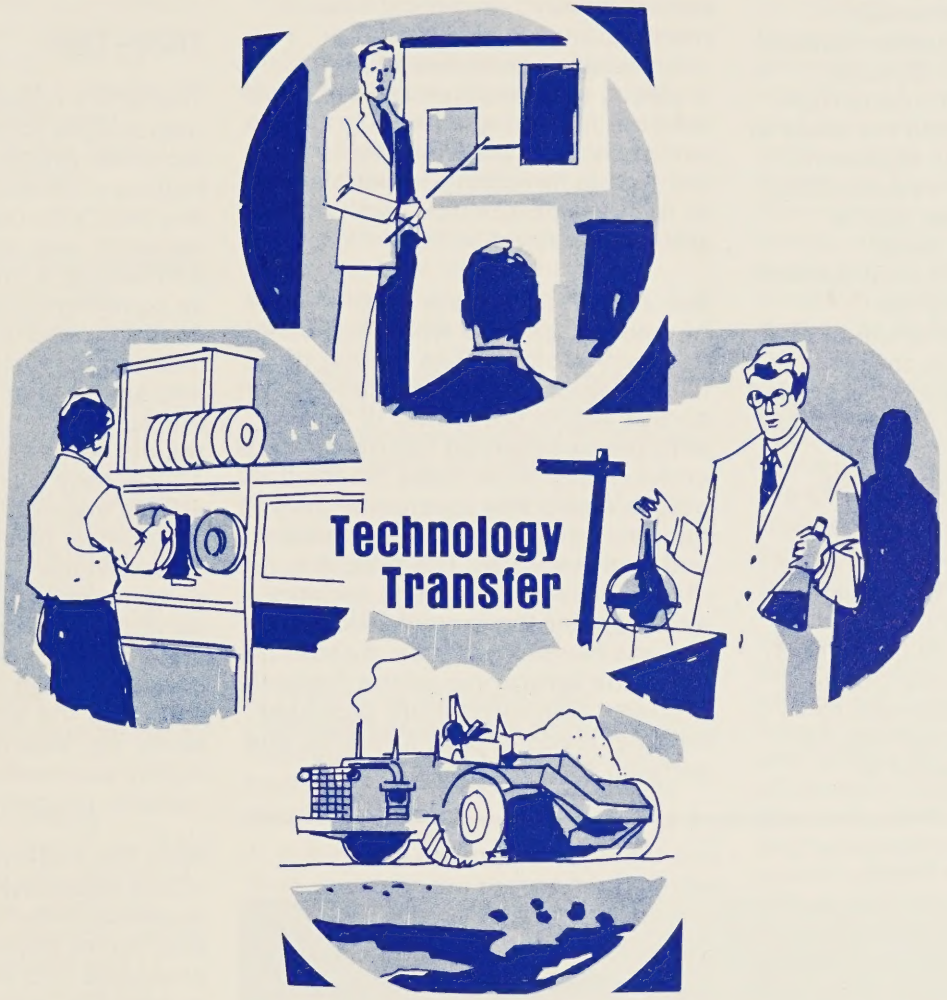
Federal Highway Administration Technology Transfer Program—A Historical Perspective

by
Milton P. Criswell



This issue of *Public Roads* is devoted to technology transfer. This article introduces the Technology Transfer Program, and subsequent articles describe the role of the FHWA field offices, Implementation Division, Demonstration Projects Program, National Highway Institute, and Experimental Projects Program in disseminating technology for application.

Introduction

Technology transfer, the process by which existing research knowledge and new technology are transferred operationally into useful processes, products, or programs that fulfill actual or potential public or private needs, (*1*)[1] can best be expressed in three words: *Get It Done*. The idea of transferring technology to economically or socially improve life is a sound one. However, people and institutions resist change so there is no easy way to insure that better ideas will be tried or that better techniques will be used. Highway transportation literature indicates that from the early days there was a continuing attempt to develop processes for shortening the time between research discovery and application. A sketchy history will be described to illustrate that research and technology transfer played a substantial and

[1] Italic numbers in parentheses identify references on page 137.

significant role in the development of the U.S. highway transportation system. (*2*)

1775–World War I

Early turnpikes in the United States were paved and maintained according to the recommendations of J. P. M. Tresaguet, Director General of the French roads from 1775 to 1785. After 1820 the ideas of the Scotsman John L. McAdam dominated American roadbuilding to the late 1880's. The 1890's launched the "good roads" movement. A key technical element of this movement was the publication and dissemination of educational articles on the principles of good roadbuilding and the economic effects of all-weather roads. Pictures were used to illustrate good and poor roads.

Highway research and scientific roadbuilding actually began with the establishment of the Office of Road Inquiry (ORI) in the U.S. Department of Agriculture in 1893. With the creation of this Office, whose primary mission was to investigate the best methods of roadmaking and to assist in disseminating this information, a formal, organized research program began. (*3*)

In 1897 as the program expanded, ORI built the first object lesson road project (fig. 1) at a cost of $321 to demonstrate the practical side of roadbuilding. Experimental construction, demonstration projects, and personalized technical assistance were applied successfully to transfer new technology involving materials such as coal tar, petroleum, local earth, and sand-clay materials.

Before 1917, the main problems for highway engineers were financial, not technological. The feeling of technological well-being came to an abrupt end in the spring of 1918 with the widespread failure of roads under heavy truck loads. Roads built before World War I were narrow and thin but adequate for automobiles and farm vehicles. The need for major research programs became evident after these road failures, and the Bureau of Public Roads (BPR, the forerunner of the Federal Highway Administration) provided national leadership in initiating and carrying forward a program of research in highway design and construction. In-house activities were expanded and cooperative research agreements were made with State highway or transportation departments and universities.

Figure 1.—Object Lesson Road.

1920–1960

The BPR's research program was responsible for solving the major technical problems impacting the highway transportation system from the 1920's through the 1950's. The research was problem oriented, addressing a range of subjects such as pavements, soils, aggregates, coating materials, design and location, capacity, economic life, and safety user costs. It was understood that useable research results would be implemented. These early technology transfer efforts involved technical assistance, publications, dissemination programs, experimental projects, demonstration projects, and considerable personal contact between those providing and those receiving the information. These same ingredients are found in the highly successful technology transfer programs of today.

With the beginning of construction of the Interstate System and the substantial increase in automobiles and trucks during the 1950's, new problems and issues, such as urban congestion, highway safety, and reducing highway construction and maintenance costs, came into focus. A full range of expanded research and development programs was developed to address these problems and issues.

1960's

In the 1960's several significant events led to dramatic changes in the concept and activity of research, development, and technology transfer in the highway program. In 1961 an independent Office of Research and Development was established in BPR with equal rank to Planning, Engineering,

Operations, and other major elements of BPR.

The Federal-aid Highway Act of 1962 required 1.5 percent of highway Federal-aid funds be used for planning and research beginning in Fiscal Year 1964. This requirement eliminated the option of using this money for construction and so insured the strength and vitality of federally aided planning and research programs in the State highway or transportation departments.

According to unpublished statistics compiled by BPR, from 1960 through 1967 the research budgets of the State highway or transportation departments increased from less than $3 million to about $23 million and the BPR administrative contract program from less than $500,000 to about $7.1 million. In 1961 the American Association of State Highway Officials (AASHO) research program, known as the National Cooperative Highway Research Program (NCHRP), was created,[2] and in Fiscal Year 1964 the budget level for this program was about $3 million.

In 1964 the Illinois Highway Research Council studied how to be more effective in getting research findings into practice. Applying potentially useable research results was strongly emphasized and approaches were suggested for improving communications to make the research implementation process more effective. (*4*)

In 1966 the Illinois Division of Highways initiated discussions with AASHO to develop an organized and adequate plan to improve the implementation of research results from the NCHRP. This set off a chain of events leading to the establishment in June 1967 of an AASHO Special Committee on Utilization of Research Findings, which included representatives from State highway or transportation departments, the Highway Research Board, and BPR.

The Committee concluded that there was "without doubt an unnecessary and undesirable timelag between the conclusion of research work, resulting in findings that should be put into practice, and the actual widespread utilization of such information." (*5*) The Committee further stated that highway officials were aware of the problem but ineffective in correcting it for several reasons including:

"1. Researchers do not present their findings in the form or language that can be immediately translated into the media of practice.

2. Researchers do not fully understand the needs of practicing engineers and others whose problems are seldom communicated in terms of research need.

3. Practicing engineers are frequently suspicious of the findings from research and are hesitant to take the lead in trying something new.

4. Practicing engineers seldom have time to study the research work that led to conclusions that may be applicable.

5. The research program frequently does not provide funds for the comprehensive test and evaluation at the field level necessary to generate confidence in the results." (*5*)

The Committee concluded that the unnecessary timelag in implementing useable research results in practice indicated the lack of an organized approach to the research implementation process. Full-time professional generalists were recommended to provide the missing link between research and operations. (*5*)

In September 1968, BPR revitalized the Experimental Projects Program by issuing new instructions to simplify the administration of experimental features on construction projects to emphasize the implementation of research findings through this Program.

In 1969 the Demonstration Projects Program was established to promote and accelerate the adoption of new research results and innovative planning, engineering, and construction practices. New or improved technology is brought directly into a transportation agency and presented to the personnel most directly concerned with the particular technology. (*6*)

At the 48th Annual Meeting of the Highway Research Board in January 1969, Francis C. Turner, Director, Bureau of Public Roads, described the BPR's planned approach to research implementation. He defined implementation as, "The process of utilizing research findings through translation into operating methods and practice," and described the elements of a structured plan for the implementation process to enhance and accelerate the implementation of useable research results. (*7*) Elements of the plan included implementation committees or coordinators in the BPR regional offices and improved dialog between R&D and the operating offices in Washington, D.C. Principles that guide current Federal Highway Administration (FHWA) technology transfer efforts were defined including:

- Obtaining the full cooperation and interest of top management.
- Involving engineers at the operations level in the research and development process.
- Arranging for testing, and evaluating research products to insure implementability.
- Developing and implementing solutions to real world problems of practicing engineers.
- Preparing and presenting research findings in a format and language

[2] A. E. Johnson, Executive Secretary, AASHO, Letter to Mr. Fred Burggraf, Director, Highway Research Board, December 1961.

that are readily understandable and useable by field operations personnel.

- Providing specialized training and information programs to aid in adopting new technology.
- Providing a flexible and responsive management framework adaptable to immediate demands. (*7*)

1970–1980

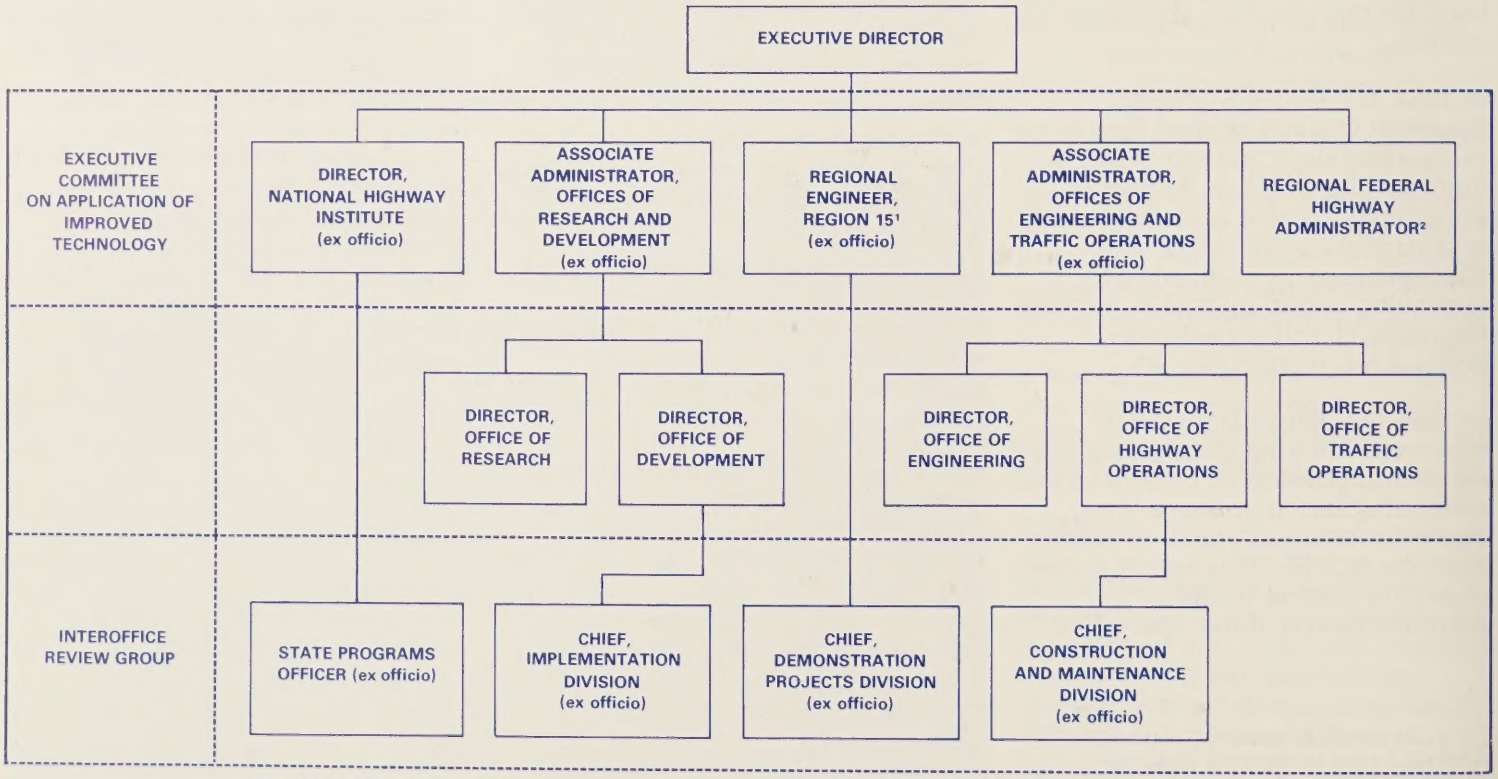
In 1970 the National Highway Institute (NHI) was created by the Federal-aid Highway Act of 1970 to develop and administer, in cooperation with the State highway or transportation departments, training programs for FHWA, State, and local highway agency employees. (*6*)

Also in 1970, the Implementation Division was established to develop, field test and evaluate, package, disseminate, and provide technical assistance on new technology. Information is received from FHWA's own research efforts, State highway agencies, and other programs within and outside of government. Material provided to users is in the form of a variety of publications, packages, kits, hardware, training programs, and data systems.

To avoid duplication of efforts and conflicts in program coordination, an FHWA Executive Committee on Application of Improved Technology (fig. 2) was created in November 1973 to provide central coordination control for implementing high priority technology transfer items. Responsibilities of the Executive Committee include establishing FHWA technology transfer goals, objectives, policies, and priorities. The Interoffice Review Group (IRG), a middle management working group composed of representatives from the Office of Development, Office of Highway Operations, National Highway Institute, and Eastern Direct Federal Division, also was established to screen and review individual technology transfer items, establish and modify specific implementation priorities, develop general and specific implementation plans, and make tentative budget assignments for high priority technology transfer items. (*1*) All technology transfer items originating from within and outside FHWA are reviewed by the IRG before work is authorized on the item.

Concurrent with the establishment of the IRG was establishment of regional and division technology transfer coordination positions in each of the FHWA field offices to provide the first coordinated

Figure 2.—FHWA Executive Committee on Application of Improved Technology and Interoffice Review Group.



[1]Direct Federal Program Administrator has assumed this position.
[2]This representative selected by ex officio members on a rotating basis and serves 1 year.

national network for FHWA Technology Transfer Program efforts. These positions clarified the technology transfer delivery system, which is essential to the success of a Technology Transfer Program of the magnitude of FHWA's. In the 1980 FHWA regional reorganization, an Office of Research and Technology Transfer was established in each Region to recognize the importance of these functions within FHWA.

1980's and Beyond

Today, participation in the Technology Transfer Program is an important function of the FHWA Washington, D.C., Headquarters, Region, and Division Offices. Technology transfer is integrated into the everyday functioning of professionals within FHWA.

FHWA continues to structure the process, improve program outputs, and provide resources to accelerate the application of new or improved technology. The cost effectiveness of FHWA's Technology Transfer Program has been proven countless times as will be illustrated in this issue of *Public Roads* in the articles relating to the specific programs. FHWA top management, the Administrator and the Executive Director in Headquarters and our officials in our field offices, strongly support the Program. Without question, the highway community understands the benefits of a strong Technology Transfer Program in the future of highway transportation. Therefore, in 1990 when the accomplishments of the 1980's are assessed, technology transfer as it has been since the 1890's will be recognized as an FHWA priority function essential to the accomplishment of our national mission.

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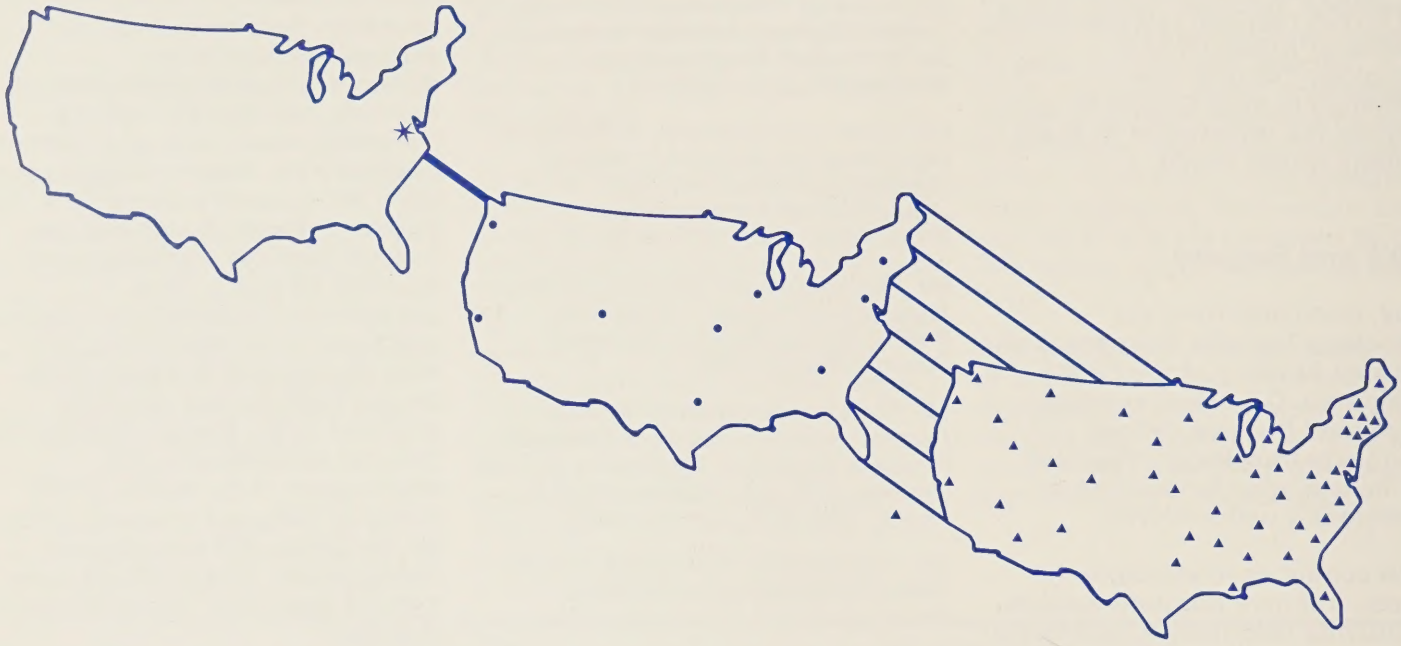
(*6*) "The Road to Technology Transfer," *Federal Highway Administration,* Washington, D.C., November 1979.

(*7*) F. C. Turner, "Implementation of Research Results: BPR's Approach," Presented at conference session on Utilization of Research Findings, 48th Annual Meeting, *Transportation Research Board,* Jan. 14, 1969.

Milton P. Criswell, formerly Director, FHWA Office of Development, retired in November 1981. As Office Director, he managed programs to develop practical applications for research results to be implemented including necessary field tests and evaluations, equipment development, and preparation of manuals, handbooks, training materials, visual aids, and computer programs for dissemination to the user. Mr. Criswell's career with the Bureau of Public Roads and the Federal Highway Administration spanned 28 years. Field assignments included area engineer positions in the New Hampshire, New Jersey, and Massachusetts Division Offices and research engineer in the Region 1 Office. Mr. Criswell transferred to the Washington, D.C., Headquarters Office in 1965 as a program officer for the Office of Research and Development. From 1972 to June 1980 he was Chief, Implementation Division.

Field Activities in Technology Transfer

by
Ray G. Griffith



Introduction

"The buck stops here." This phrase may be passe, but the words still apply to the user of technology. It is the user who must receive, evaluate, and decide to apply improved practices, procedures, materials, and techniques through a "media of practice" such as plans, specifications, standards, and operating procedures. Ultimately, the user of technology controls advancement.

In the highway community, the users of technology are found at all levels. However, the majority are located in the States, cities, and counties where highway transportation facilities are actually being purchased. It is at these levels where highway needs are identified and the necessity of applying new techniques, procedures, and practices to accomplish more with limited resources is most evident. Consequently, efforts to generate positive technological change are focused at these levels.

Technological change is needed to manage the incompatibility between increasing highway needs and decreasing resources. Research can point the way, but the results must be *transferred* into practice. Commitment to technology transfer is required by everyone involved in the highway program, including the Federal Highway Administration (FHWA) Region and Division Offices (commonly referred to as the "field offices").

The FHWA field offices are an important part of the technology transfer process because the staffs provide a link between many users at the State and local levels and outside sources of new technology.

This article reviews the roles of the field offices in the Technology Transfer Program. Selected activities, procedures, and approaches that are being used or have been used to fulfill these roles are discussed briefly. A few approaches to technology transfer used by State highway agencies also are described. Generally, the approaches selected are designed to facilitate the interface between FHWA and State users. Some of the approaches for delivering technology to the large "local" user group also are mentioned.

Roles of the FHWA Field Offices

FHWA's formal Technology Transfer Program was derived from the realization in the mid-1960's that technological advancement simply was outdistancing the application of new technology. The background of the Program, discussed in the previous article, and the FHWA organizational structure influenced the roles that have evolved for the field offices. The two main roles are:

1. To serve as a communications link among the various sources of new technology (including the FHWA Washington, D.C., Headquarters program offices, States, and industry) and those States and local highway agencies that can apply the technology in daily operations.

2. To encourage throughout FHWA and in State highway agencies organizational structures and personnel assignments that help transmit available technology from any source to actual field use.

Numerous functional statements and operational plans have evolved from the above roles. Almost as many approaches exist as there are FHWA field offices, and the functions of the Regions are distinguished from functions of the Division Offices.

Regional Office technology transfer functions

Although functional statements in an operational plan must be fairly detailed, the following general statements suggest some of the activities required to fulfill the roles.[1]

1. Identify and evaluate unique and beneficial research results and current practices for application at the State and local levels within the Region.

   a. Consider results and practices originating both within and outside Regional boundaries.

   b. Plan, develop, and use application aids such as user packages, demonstration and experimental projects, and training programs.

   c. Maintain communication with Headquarters elements of the technology transfer program, including recommending interregional application of Regional products.

   d. Perform surveillance and evaluation as appropriate to insure application of proven technology.

2. Develop and promote multidisciplinary programs for the application of promising research results in highway engineering within the Region.

   a. Develop viable organization structures and mechanisms in the FHWA Division Offices and State highway agencies for evaluation and application of new technology.

   b. Cooperate and interact with other elements of FHWA, State highway agencies, industry, and related organizations as appropriate to evaluate the effectiveness of the technology transfer programs.

Division Office technology transfer functions

Functional statements for the Division Offices are similar to those for the Regions, but usually reflect a direct interface with the State highway agency.[2]

1. Evaluate results from the State's research studies, identify implementation potential, promote use by the State, and communicate results of application to others.

2. Evaluate new technology items from sources other than State research studies and, if warranted, design and conduct promotional efforts with State, city, county, and other local users.

3. Encourage participation in the Demonstration and Experimental Project Programs.

4. Evaluate the results and benefits of the technology transfer process.

Field Approaches to Technology Transfer

Most FHWA field offices have a technology transfer coordinator. In some cases the Deputy Regional Administrator has been designated coordinator for the Region, and in other cases, the Director, Office of Research and Technology Transfer has this assignment. In the Division Offices, the Assistant Division Administrator usually is the technology transfer coordinator. Occasionally, the Field Operations Engineer, the Transportation Planner, the Bridge and Technology Transfer Engineer, or the Bridge and Research Engineer has been designated.

Several field offices now have active technology transfer committees that may function in different ways but generally are chaired by the designated technology transfer coordinator.

[1] These statements are generalized from operational plans for Regions 4 and 8.

[2] Statements extracted and generalized from FHWA North Carolina Division, "Plan of Operation for Division Technology Transfer Committee," adopted October 1976, updated April 1981.

The need for management support of technology transfer in the field was recognized in the program's infancy. The direct involvement of the Deputy Regional Administrator and the Assistant Division Administrators is believed to reflect such support and also facilitates the continuing involvement of all Regional and Division staff disciplines in ongoing operations. The implementation groups further facilitate this interaction and encourage cooperation among various disciplines.

The Florida and Utah Division Offices' approaches to technology transfer committee operations involve Division staff and include State highway agency participation as well. In Florida, the Director of Construction and Deputy State Materials and Research Engineer are members of the Division technology transfer committee. The State Engineer of Research and Development and the Implementation Engineer are members of the committee in Utah. Operation of both committees appears to be similar. Reports are screened by the committees to decide on the applicability of particular new technology. This is critical to any approach to the field technology transfer program. Both committees also have systems for tracking or monitoring technology items that are considered. (*1*)[3]

A new technology item remains on the Utah committee's agenda until it is decided whether or not to apply the item. Florida's approach is similar, with the Division technology transfer committee keeping current summaries on the many items that are delivered through the technology transfer program. This monitoring procedure enables followup—an activity that is also critical to whatever approach is selected for working the program. Most of the field offices have recognized this need. A 1978 national evaluation of the field technology transfer program by FHWA Headquarters revealed that "up to two-thirds of the Divisions have devised some type of inventory control by which they can assess the status of the various technology transfer efforts. This enables them to determine if they have been successful in having the State implement the item and keeps the various functional areas informed on items in their areas of responsibility." (*2*)

Some States also have developed monitoring systems. The Virginia Highway and Transportation Research Council uses a special "green sheet" to record specific research recommendations and to track these items until official action is taken. Florida's operating procedures provide the Director of Construction, who is also responsible for technology transfer in the Department, with a written evaluation on each item and a conclusion about its applicability. Utah uses a review form that is completed by the potential user group and returned to the Implementation Engineer. The implementation process in the Utah Department of Transportation is shown in figure 1.[4]

In addition to Division technology transfer committees where both State and FHWA personnel are members, there is the variation offered by Colorado where the Division Office coordinator is a member of the State's implementation committee.

In 1976, the Colorado Department of Highways established a technology transfer group in the Research Unit. In addition to supporting the implementation committee and its activities, the group has periodically presented exhibits and discussed research on Colorado highways and other technology transfer matters with personnel throughout the agency. The technology transfer program is reportedly better understood by Department staff as a result of the efforts. (*3*)

Other States also have established technology transfer units. Those involved in the 1978 national evaluation noted that "due largely to the efforts of our field people in the program, a dozen or so States now have technology transfer sections in their highway agencies, and the number is continuing to increase." (*2*) Indications are that States that have established technology transfer units have found them to be productive.

There may be other effective approaches to the technology transfer program. In South Carolina, for example, there is neither a formal State highway agency organization for conducting technology transfer activities nor a Division Office committee. However, a proportionate number of technology transfer items are being implemented. Apparently this is because the entire Division Office is involved in the program and a good professional relationship exists between State highway agency and FHWA engineers involved in a one- to-one type approach to technology transfer. (*4*)

The South Carolina approach, although not a formal one, reflects interest and enthusiasm for the program—important elements in any approach. "FHWA and State highway agency personnel serving in the technology transfer area must be enthusiastic about the 'positive change' potential of their work and, of necessity, be salespersons for the program." (*3*) This suggests that people make things happen and emphasizes the point that ". . . new ideas do not sell themselves—they often need help." (*5*)

[3] Italic numbers in parentheses identify references on page 144.

[4] "Manual of Instruction, Part 9, Research and Development," Draft document, *Utah Department of Transportation*, July 1976.

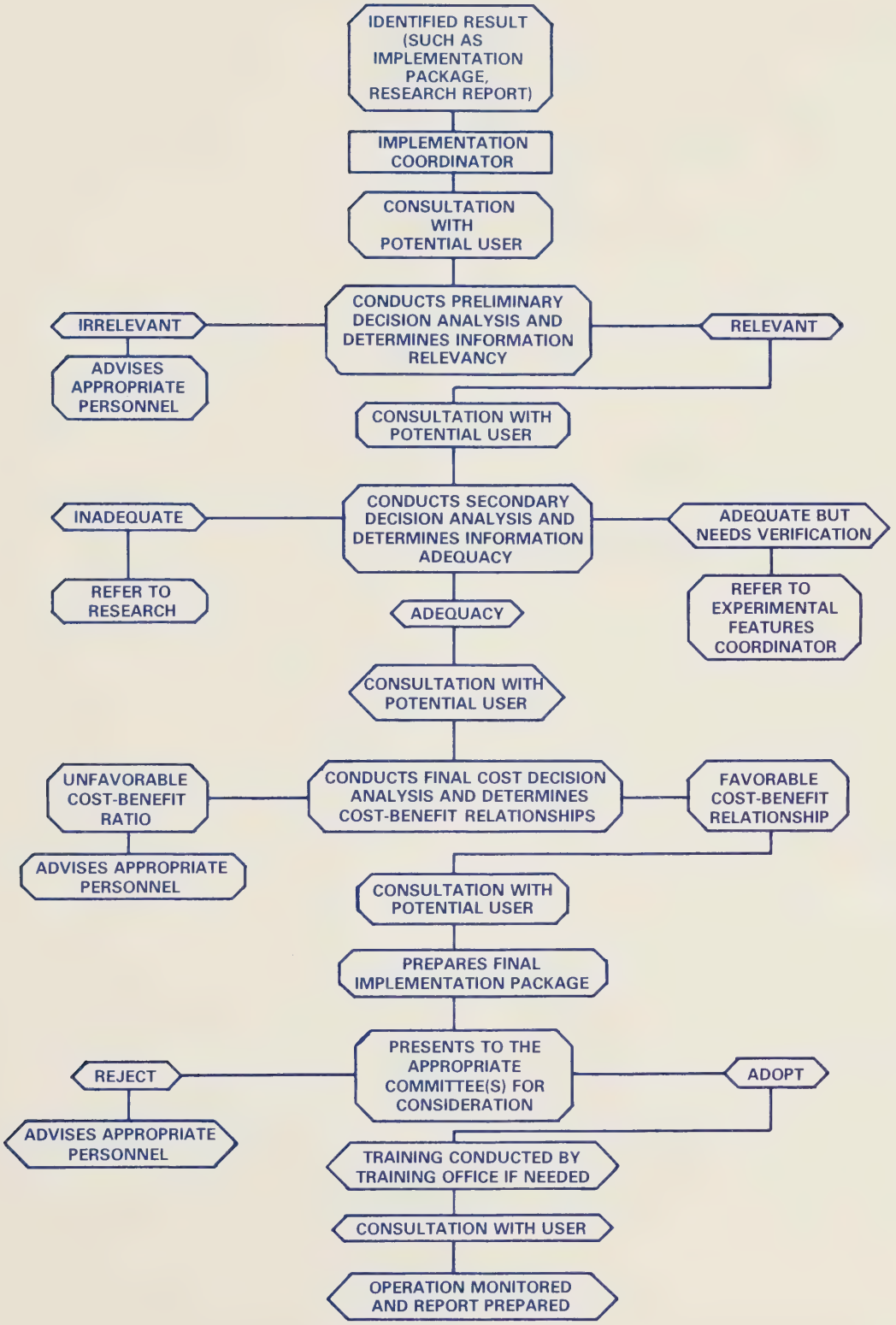


Figure 1.—Utah Department of Transportation implementation process.

Although other field office and State highway agency approaches to the technology transfer program could be described, it is suggested that the more effective approaches address the elements reflected in the preceding examples. The most critical of these elements follow.

- An assessment of the technology item and a conscious decision about its applicability to the operation of the particular unit for which it is being considered.
- The communication of the technology transfer item to the potential user in terms and in a method that facilitates assimilation and application.
- Enthusiasm for new and better ways of accomplishing the tasks at hand.
- A procedure for followup and feedback.

Further, these critical elements are most likely to receive adequate attention if the approach uses a structured technology transfer committee.

Field Activities Designed to Deliver Technology to Local Highway Agencies

Cities, counties, consultants, contractors, universities, and even other Federal agencies at the local level constitute a large group of potential users for much of the new highway technology. The group is significant because of its size and also is important when need is considered. "The Federal Government bringing its resources in technology right down to very practical things on the local level is a very good example of what we need."[5] This observation by a local official is appropriately interpreted as support for the transfer of new technology to the local level.

Similar indications are noted in North Dakota. In November and early December of 1979, the North Dakota Highway Department sponsored several "local public road workshops." These workshops generated information on road issues and problems confronting local units of government that led the workshop coordinators to recommend the following:

- The initiation of a quarterly construction and materials newsletter to keep local road departments aware of changes in technology related to construction and maintenance of highways.
- Actions to improve the availability and kind of training offered to local road department employees. (*6*)

Many field offices and State highway agencies have taken on the challenge of delivering technology to cities, counties, and other groups. Brochures with franked forms for convenient ordering of technology documents have been distributed; some States and Divisions have established mailing lists and distribute these brochures regularly. In addition, field offices and States have participated in meetings of local groups, published newsletters, provided workshops and seminars, and participated in exhibits. The following are examples of successful activities.

Region 9 Roadshow

Among field office technology transfer activities directed toward local governments, perhaps the most aggressive is operated by FHWA's Region 9 Office of Research and Technology Transfer in San Francisco, Calif. The effort, called the Roadshow, approaches delivery through technology transfer presentations to local agencies, city and county associations, and a number of special district groups. The Roadshow is complemented by a quarterly newsletter, "Technology Transfer Update," which describes recent activities as well as new items in the technology transfer program to a large number of recipients. Response to the newsletter has been excellent.

A catalog of technology transfer presentations is provided to representatives of local groups for use in selecting items to meet their specific needs, although presentations are tailored on request. A unique feature of the effort is the housing of projection equipment and the Region's film library in a van dedicated to the Roadshow. The van is used in responding to invitations to participate in meetings, and the availability of the film and audiovisual equipment enables spontaneous response to group needs. In Fiscal Year 1980 the Roadshow effort resulted in 50 presentations to 1,600 people. Division Offices and State highway agencies in Region 9 fully support the Roadshow.

Workshops and seminars

At a conference on research and development management for transportation research and development managers it was concluded that officials and staff of local governments are best informed about new highway technology through such mediums as construction conferences and association meetings. (*7*) Among the State highway agencies using these mechanisms is the Georgia Department of Transportation, which has established technology transfer as a major function of the Operation Branch in the Research and Development Bureau. The training-through-workshops approach has been used to spread

[5] Mayor C. Reynolds, West Hartford, Conn., in the video tape "Intergovernmental Management: The Task Ahead," by the Study Committee on Policy Management Assistance for the U.S. Office of Management and Budget, Washington, D.C., *National Audiovisual Center*, 1975.

new technology throughout the State. A workshop on road maintenance training programs, for example, was held for cities and counties in seven locations. (*8*)

The Utah Department of Transportation recently built the modified excess oxygen burner device for pavement stripe removal and demonstrated it throughout the State for local officials as well as for its own personnel. The Virginia Highway and Transportation Research Council has held three technology transfer workshops for cities and towns and expects to continue this activity annually.

Participation in exhibits

Several field offices have initiated technology transfer booths at State highway conferences, various secondary road and public works meetings, engineering society meetings, selected technical conferences, and in connection with college- and university-related activities. (*2*) The attractive standup display shown in figure 2 portrays each of the four Headquarters technology transfer elements. Handouts are arranged on a table in front of the display.

University Public Service and Research Association

Other groups outside of official highway agencies are interested in technology transfer. In several colleges and universities, small groups respond by telephone and with onsite consultation to problems brought to their attention by local officials. Those involved in this activity have organized the informal University Public Service and Research Association. Partial funding by the National Science Foundation helped initiate this program.

Figure 2.—Standup technology transfer display used in exhibits.

Conclusion

The University Public Service and Research Association demonstrates the fact there are groups outside the official highway community interested in the transfer of technology to local agencies. Other groups could be cited. These groups may offer viable channels that can supplement field office and State highway agency efforts to deliver new technology directly to cities and counties. The challenge is to be sensitive and respond positively to opportunities to work with these groups, assisting in both delivery of technology and maintaining an internal awareness of new technology.

Other approaches to working with local units of government probably exist, just as there are activities and procedures for field office and State highway agency technology transfer interactions that have not been included in this article. The examples that have been mentioned were selected because an active approach—a desire for positive technological change—was reflected even though a formal technology transfer structure might not be operational. It seems clear that new technology is being applied more rapidly where the approach to technology transfer is active rather than passive.

New technology has been applied over the years and will continue to be applied even with a passive approach. The rate at which technology is applied generated the concern evident during the late 1960's and early 1970's. This is a viable concern today when the economic environment demands accomplishing more with less. New practices, procedures, materials, and techniques that help meet highway needs must be sought and applied.

The entire highway community has a role in responding to this demand. The role of FHWA field offices is to identify and communicate efficiently new technology to potential users at the State and local levels. Encompassed in this role is a sensitivity to the existence of new technology within a State or Region, determination of the technology's potential benefit to the highway program, and the development and communication of the product to users. The role includes field office interaction with the FHWA Headquarters technology transfer elements, reporting new technology developed locally, receiving products from external sources, using available communication tools, and providing information on productive technology transfer items. The role also involves

interaction with numerous other sources and users such as universities, consultants, contractors, and suppliers. In short, fulfilling the role expands the State and local users' sources of new technology and enhances the understanding, evaluation, and application of the technology.

Technological advancement is recognized as a kind of spiral with no identifiable beginning or end. The technology transfer process discussed in this article, however, begins with the research product and concludes with its deployment in the highway program. FHWA field offices, as members of a much larger team, are an important part of that process. Yet, in the end, it is the entire highway community's commitment to providing a safe and efficient highway transportation system in the most cost-effective manner that makes advancement a reality.

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Additional information on the field office technology transfer program can be obtained by contacting the FHWA Regional Offices (see page 178).

Implementation of Highway Research: Yesterday, Today, and Tomorrow

by
Robert J. Betsold

Introduction

A new golf ball has been produced. You are encouraged to try it because it flies farther and straighter than other balls, and stops better on the green. A toothpaste sample received at the supermarket promises brighter teeth, fresher breath, and fewer cavities. Advertising campaigns on radio and television, in newspapers and magazines, on billboards and buses all praise new products. Is all of this cost and effort really necessary? Yes, because new products and ideas do not sell themselves—they must be brought to the attention of the consumer.

The marketing effort in private industry has a counterpart in the public sector. This effort, technology transfer, has been used by many agencies to encourage further application of the results of Government-sponsored research and development (R&D). An indirect but substantial benefit of the U.S. space program has been the new materials and technology produced and transferred by the National Aeronautics and Space Administration. Much of this technology has benefited the everyday lives of the American people. Technology transfer and technical assistance by the U.S. Department of Agriculture to the Nation's farmers also have provided substantial benefits. In this program, county agents successfully have linked agricultural science to farm practices.

Yesterday

In the highway program, technology development has a long history. Research was one of the principal missions of the first national highway program in the United States and is, in fact, the oldest continuous Federal highway activity.

Over the years, various methods were used to transfer research findings and make highway expertise available to the Nation. These included the Object Lesson Roads Program (1897–1910), the Good Roads Trains (1901–1903), and the Road Improvement Trains (1910–1916). (*1*)[1] Also *Public Roads* magazine, first published in 1918, has served to widely disseminate research findings to the highway community.

In 1920, the National Advisory Board on Highway Research (later known as the Highway Research

[1] Italic numbers in parentheses identify references on page 152.

Figure 1.—Production cost study on mixing times for large central mix concrete plants—North Haven, Conn., 1964.

Board and now the Transportation Research Board) was established to "collect and distribute information." Mr. Roy W. Crum, Director of the Highway Research Board from 1928 to 1950, stated, "The end product of our work is useable technical information, but it will be of no value to anyone unless it is learned and put to use by the technical man." (*2*)

Federal-aid for State highway planning and research began with the Hayden-Cartwright Act of 1934. With the approval of Federal funds for State highway research and testing activities, communication between Federal and State researchers increased. Transfer of highway technology also advanced through many Federal-State cooperative activities including various road tests to study pavement performance, production cost studies to analyze the use and operational efficiency of construction equipment (fig. 1), accident evaluations of the Interstate Highway System, and highway capacity studies.

Through the years, there was a strong movement to expand and strengthen the practical use of highway research. However, in the late 1960's it became apparent that highway transportation problems were becoming too large and complex, and insufficient attention was being given to putting the extensive research findings into practice. Skilled promotion was needed to gain managerial support, to overcome inertia and resistance to change, and to insure the essential actions for public acceptance. (*3*)

Responding to this problem, the Federal Highway Administration (FHWA) created a separate Office of Development in 1970. After initial adjustments, the R&D organization was structured as shown in figure 2.

Within the new Office of Development, the Implementation Division specifically was assigned to provide "leadership in the entire implementation process" and to serve as the "control, coordination, and management activity for translating into practice the results of research and development." (*4*)

Today

With the cooperation of the Office of Research, FHWA program offices, and the Interoffice Review Group (described on page 136 of this issue), the Implementation Division has, for the past 10 years, provided the desired linkage between research and practice. This effort has been successful because of good staffing practices, strong financial and program support, a logical hierarchy of implementation techniques, good cooperation with program offices in the Washington, D.C., Headquarters, and a well organized and geographically distributed field structure to encourage hands-on application of new technology.

Staffing practices

During the 1970's FHWA strongly encouraged geographic mobility among its employees. The Implementation Division supported this policy and benefited from the flow of engineers from the field offices. These engineers were promoted to implementation manager positions in Headquarters with the understanding that they could return to the field after a 2- to 5-year assignment. Working with senior managers in the Implementation Division, these implementation managers became knowledgeable in areas such as highway safety, traffic engineering, environment, and pavement management. With their general engineering background and field experience and their on-the-job training in implementation techniques, they provided the

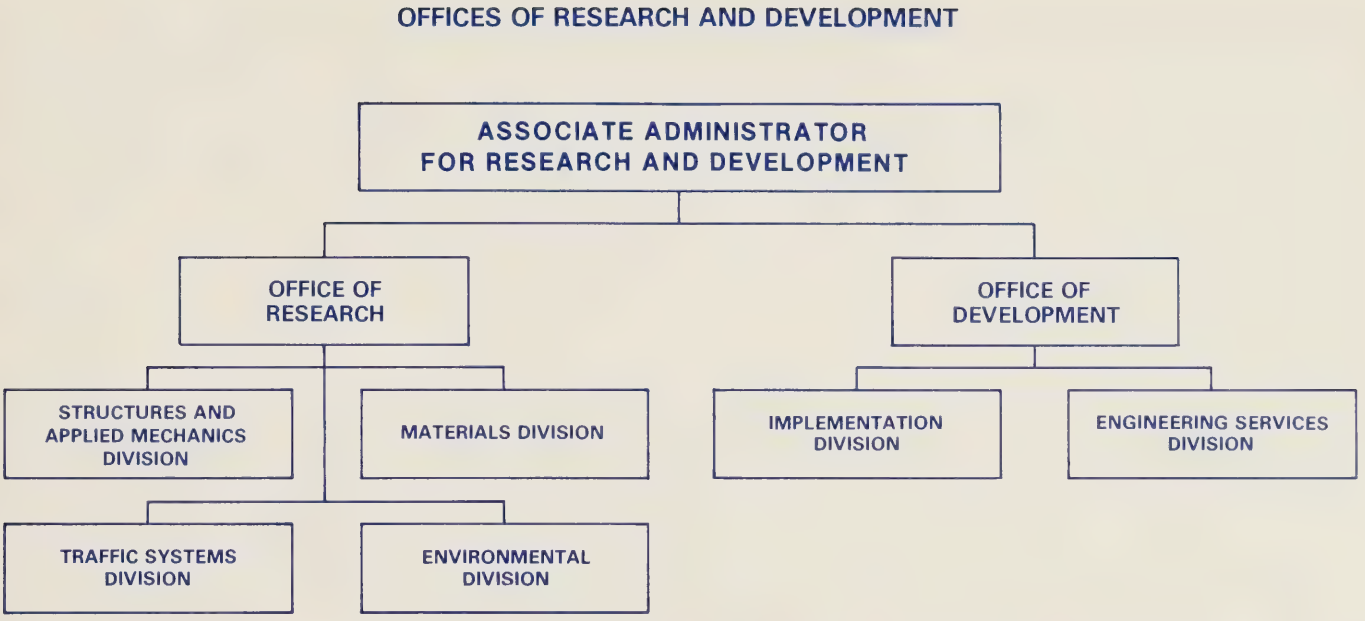


Figure 2.—Offices of Research and Development organization.

missing link in the research-to-practice chain. Most of these engineers were highly successful in translating the technical jargon of the researcher into useable information that could be readily understood and accepted by field engineers. As an extra benefit, when they completed their assignment and transferred back to the field, most retained their interest and involvement in technology transfer activities.

Program support

The implementation program was well supported by agency policy and financial resources. Technology transfer was identified in 1975 as a specific FHWA Program Emphasis Area. In addition, approximately 15 to 20 percent of the annual R&D administrative contract funds were allocated to implementation activities. Compared with other Government agencies, this represents a substantial commitment of the R&D resources. The Stevenson-Wydler Technology Innovation Act of 1980 requires certain Federal laboratories, after September 30, 1981, to allocate at least 0.5 percent of the agency's R&D budget "to support the technology transfer function at the agency and at its laboratories." (*5*) Obviously, the FHWA program far exceeds the Congressional requirement.

Implementation techniques

A variety of methods are used to test and evaluate research findings and to pass the technology to potential users. Methods involving active participation of the user are selected for items with the greatest need or implementation potential. Methods used include:

- Training course development and pilot presentations.
- Conferences, workshops, and seminars.
- Industry disclosure meetings.
- Task orders with State highway agencies.
- Technical assistance by R&D staff.

Other high priority items considered to be of national interest are disseminated through active promotional materials including: films, video tapes, slide-tape presentations, and computer programs.

The least expensive means of dissemination involves written materials including: implementation packages, programed instruction training materials, user manuals, handbooks and guides, technology sharing reports, technical advisories, and brochures.

These materials are prepared by private industry, universities, nonprofit organizations, FHWA R&D staff and program offices, other Federal agencies, and State, county, and city highway agencies. The cost and quality of the items vary, but the intent remains the same—to get the material to the potential user in a readily understood and accepted form.[2]

[2] A detailed explanation of the FHWA implementation process is found in "Getting Research Into Practice," by Gerald D. Love, *Public Roads,* vol. 42, No. 2, September 1978, pp. 41–47.

Cooperation with program offices

The implementation program is solidly supported within FHWA. Program office managers recommend activities for the annual program, and their staffs help the Implementation Division staff prepare requests for proposals. Program office personnel also provide valuable technical advice by serving on proposal evaluation panels and monitoring the activities through the final product distribution stage. At that time, program offices frequently become the principal sales force for the new technology.

The implementation program has been designed to accept targets of opportunity or high priority items that occur. This flexibility is essential because R&D is a service organization, and timely response must be available to meet the needs of Headquarters and field offices.

FHWA field structure

The FHWA field organization (described on pages 138–144 of this issue) is a major factor in the success of the implementation program. Research and technology transfer directors in each of the nine FHWA Region Offices distribute and promote materials received from Headquarters. Staff in the FHWA Division Offices located in each State insure that materials reach appropriate staff in the State highway agencies. Like the county agents in the U.S. Department of Agriculture, FHWA Divisions provide the final, face-to-face link to encourage the acceptance of new ideas or materials.

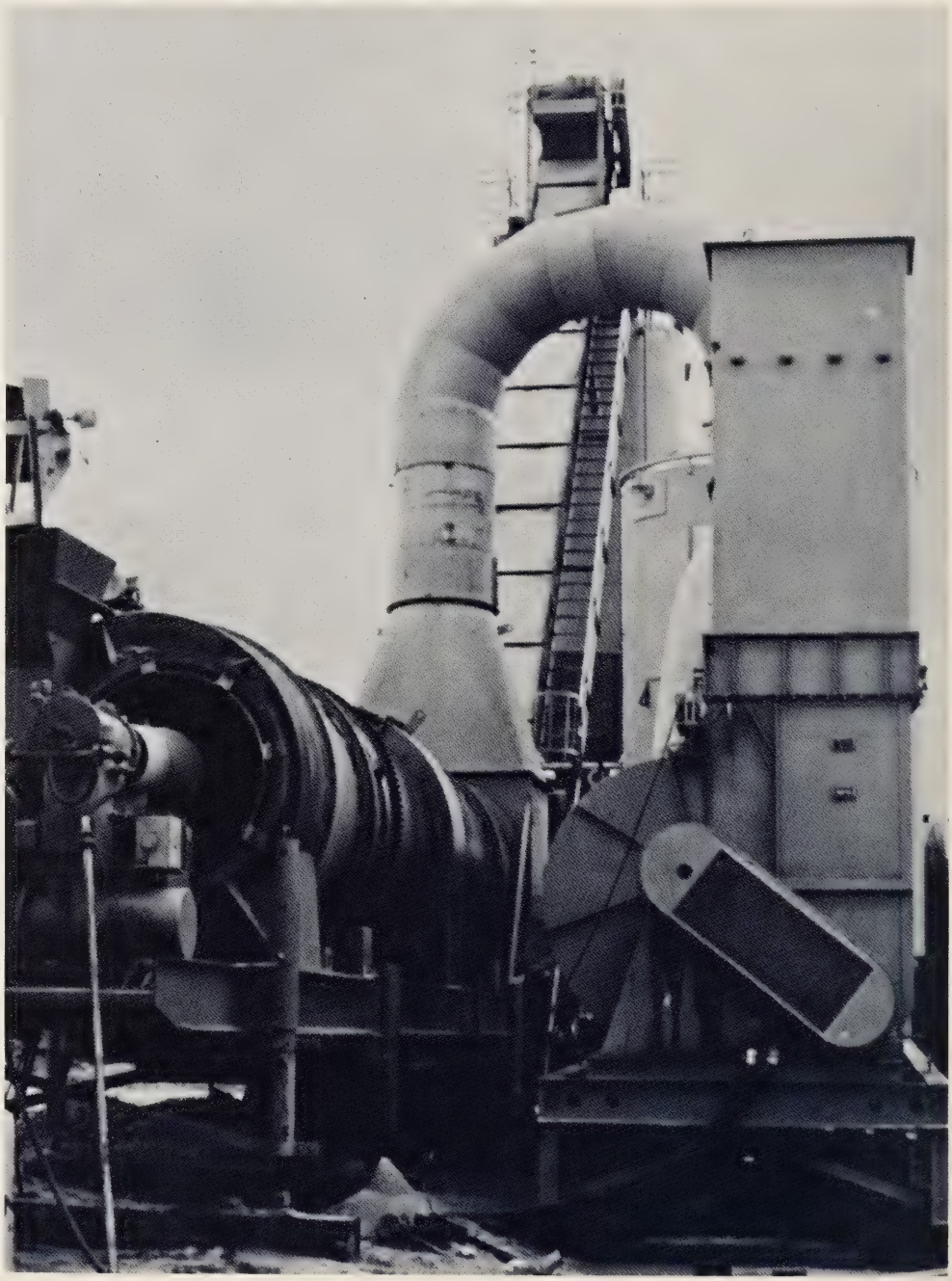
Success Stories

A few of the many implementation successes of the R&D program include:

- *Dryer Drum Mixer.*—Development and evaluation of the dryer drum mixer for producing hot-mix asphalt concrete led to the widespread adoption of this innovation in asphalt paving.technology (fig. 3). Virtually all new hot-mix plants currently sold in the United States use dryer drum mixers because the capital and operating costs are significantly lower than the costs for pug-mill mixers.

- *Traffic Controller Synchronizer (TCS).*—A low-cost technique for wireless interconnection of traffic signals at urban intersections was developed to improve traffic flow and reduce fuel consumption. The TCS is a solid-state, time-based unit that coordinates existing traffic signal controllers without expensive interconnecting cable, radio, or optical links. (*6*)

Figure 3.—Adoption of dryer drum mixer technology.



• *Soil Stabilization in Pavement Structures.*—This users manual was cited by a national industry organization as a fine example of putting Federal money to excellent use and selected by the National Lime Association and the National Ash Association for distribution to their members.

• *Raised Pavement Markers in Construction Zones.*—At the request of the FHWA Office of Highway Safety, the Offices of R&D initiated a study with eight States to evaluate the use of raised pavement markers for construction zone delineation. The study concluded that raised pavement markers provide excellent temporary delineation and nighttime accidents are reduced, thereby justifying the cost of the markers. At least 13 States have now adopted this practice.

• *Value Engineering Studies of Selected Maintenance Activities.*—Since 1974, the Implementation Division has initiated 12 separate studies using value engineering techniques to analyze maintenance activities. Each study, conducted by teams of engineers from three or four States, determined optimum maintenance methods for specific activities such as shoulder maintenance, bituminous patching, mowing operations, and bridge painting. Annual cost savings for the States involved in the studies have been estimated to be over $8 million.

• *Self-Powered Vehicle Detector (SPVD).*—This wireless detector (fig. 4) was developed over an 8-year period by the Office of Research. After field tests and evaluations demonstrated the effectiveness of the SPVD, an industry disclosure conference was held in 1981. Representatives of the traffic control and electronics industries are considering commercial production of this device, and strong interest has been shown by State and city traffic engineers.

Figure 4.—Self-powered vehicle detector.

Other examples of successful applications of research results include the Urban Traffic Control System (UTCS), hydraulic design of bridges using risk analysis, use of polymer concrete materials, pavement stripe removal by high temperature burning with excess oxygen, and snowplowable pavement markers.

Tomorrow

Although the implementation program was successful in the 1970's, additional improvements and refinements are needed to meet the problems of the 1980's. Both the technology transfer program and the Offices of R&D organizational structure recently have been reviewed by the FHWA Office of Management Systems. These reviews, and independent assessments by R&D managers, have revealed important issues and suggested positive actions to improve the implementation process. The major issues, and actions being considered to address these issues, are as follows:

1. There is a need for greater collaboration between the researchers and the implementors to eliminate the hand-off that can occur from research to development. The researcher initiates the original work and pursues the study to conclusion of the research phase. The research results are then handed to the implementor for any necessary field test and evaluation, refinement, packaging, and promotion. Although this system can work, there are disadvantages. First, the implementation potential of a research study may not be considered during the earliest stages of the research process and such consideration is essential because the FHWA R&D program is an applied program, and work should be undertaken to fill an existing or anticipated need.

Second, when technology passes from research to development/implementation, there is little incentive for the researcher to continue to provide technical advice or for the implementor to seek such assistance. Fortunately, there are many instances where this professional and personal interaction is maintained.

These problems are compounded by the geographic separation that now exists between the Implementation Division and three of the four Divisions in the Office of Research. This physical separation problem will be solved when the new addition to the Fairbank Highway Research Station in McLean, Virginia, is completed in late 1982. The new structure will include additional laboratory space as well as offices for the Implementation and Environmental Divisions currently located in the Department of Transportation Headquarters in Washington, D.C. Co-location should encourage greater contact between the researchers and the implementors.

To smooth the transition from the research phase to the development phase the project team approach to technology development and transfer should be emphasized, with the researcher having a lead role during the early stages of the process and the implementor assuming greater responsibility in the later stages. Special talents of the researchers and the implementors can be combined throughout the process to create a synergistic effect, resulting in research activities responsive to genuine needs and final products technically sound as well as useable by the practitioner.

2. Until recently, there have been no formal mechanisms for determining with the program offices which research outputs should receive priority for implementation. Interaction occurred at the staff working level, and those people in the program offices who displayed the greatest enthusiasm and willingness to work with the implementors could get a disproportionate share of the resources. Despite continued efforts of top R&D managers, it was difficult to get consistent involvement and advice on R&D program content and priorities from some program office managers.

In the spring of 1981 the Federal Highway Administrator requested high level reviews of the proposed Fiscal Year 1982 R&D program, and signed concurrences by key program office officials for all actions exceeding $50,000. Substantial time and effort was devoted to these reviews, and the outcomes were gratifying in terms of increased understanding of the R&D program and agreement on priority actions. Recently, a formal Contract Program Review Board composed of key associate administrators and chaired by the Executive Director of FHWA was created for "assessing individual requirements in the light of overall FHWA program priorities, and for insuring the appropriateness and cost effectiveness of the methods used to satisfy program needs." (*7*) This high level interest and involvement will assure that the R&D program is truly responsive to the overall needs of the agency.

3. The financial crisis that affected State and local governments in the 1970's has now reached the Federal level. Personnel and budget cuts are already occurring, and actions to reduce costs and increase efficiency will continue to be emphasized in the coming years. Reviews of the Offices of R&D organization have indicated several actions that could consolidate activities and reduce the management structure. Depending on the depth of the cuts, it may be necessary to eliminate some of the current services or programs provided by R&D. Regardless of the final form of the organization, the implementation function will be continued. During recent reviews of one of the proposed organizational changes, program offices in Headquarters and FHWA field offices voiced overwhelming support for the implementation activity.

4. The implementation program should continue to be evaluated to insure that necessary activities are undertaken and that high quality materials are reaching the intended audience. Feedback from FHWA field offices and from State and local highway agencies is essential for program evaluation. Feedback systems have been discussed with FHWA Regional Directors of Research and Technology Transfer, and a reporting form is being reviewed. The information should help to keep the program on track and provide data needed for Congressional budget reviews.

5. New or improved methods for technology transfer to city and county highway agencies and to special target groups must be explored. The problem of reaching local governments with new technology is augmented by the number of agencies involved. In New York there are over 1,600 local government units with highway or bridge responsibilities and over 2,600 such units in Pennsylvania. Various means have been used to inform these local agencies about new highway technology. In some instances the State highway agencies have local road units that technically assist or inform the local units. In other cases State universities have outreach programs that provide technical guidance or conduct periodic short courses for county and city engineers. In the implementation program, brochures announce the availability of new technology and include an order form so the report

or manual can be purchased from the Government Printing Office. These brochures are distributed to mailing lists maintained by the FHWA Division Offices or by the State highway agencies. New technology items applicable to local governments also are announced through newsletters or magazines published by such organizations as the Institute of Transportation Engineers, the Urban Consortium, the National Association of Counties, and the National Association of County Engineers. In addition, some new technology items are cited by trade journals or magazines such as *Paving Forum, American City and County, Public Works, Rural and Urban Roads,* and *Better Roads.* With cutbacks in Federal printing budgets and new restrictions on Government publications, these organizations and publications will be relied on more heavily to spread the word.

Even within State highway agencies it can be difficult to reach potential users. A recent study of highway maintenance research needs recommended that the "highest priority be directed to expediting and initiating a new, more effective program for R&D implementation and technology transfer for highway maintenance." (*8*) A study to address this problem is included in the Implementation Division's Fiscal Year 1982 contract program.

This delivery problem also is reflected in other areas. Reviews of suggested research problem statements for the National Cooperative Highway Research Program and responses to FHWA research problem solicitations consistently reveal problem areas where R&D has already provided solutions. Unfortunately, the technology is not reaching operational personnel in many States and is reaching even fewer counties and cities. Continued efforts in this area will be needed.

Cautions

In the zeal to consolidate operations and refine the R&D process, managers must proceed cautiously so the capability and strength of the existing system are not lost. An increased focus on outputs should not deter R&D managers from including some longer range or higher risk activities in their programs. Because of the long leadtimes required for major research projects, R&D must look ahead and anticipate the problems that will face the highway program. The program must also include high risk activities when warranted by the potential payoff. In each of these areas the R&D managers must continue to defend some of their programs against an operational philosophy that naturally focuses on yesterday's and today's problems. Perhaps these managers could cite the experience of Chester Carlson who took his Xerox invention to over 20 companies before he was able to make a sale. No one except Carlson himself envisioned the need for his process or believed that it was practical. (*9*)

Care also must be exercised if the project team approach is expanded. The highly technical orientation of the researchers must be retained and they must continue to have the opportunity and facilities to conduct original research. The current R&D staff includes nationally and internationally recognized experts in many areas of highway technology. This outstanding technical expertise has been a major and continuing factor in the value and success of FHWA and its predecessor organizations. At the same time, the value of the experienced generalist, who can develop, field test, evaluate, and translate new technology to user language, must be acknowledged. The generic problems of technology transfer identified in the 1960's can reappear if the trained implementation staff is lost. These individuals must continue to fill the missing link between research and practice.

Finally, the move to the Fairbank Highway Research Station will consolidate the R&D staff but remove the implementors from their current proximity to the program offices. Concerted efforts must be made to insure that frequent, personal contacts are maintained with the program office personnel. The R&D staff cannot effectively serve from afar; good communication, understanding, and mutual respect must be nurtured by managers on both sides of the Potomac.

Conclusion

FHWA has a successful history of technology development and transfer. As resources and requirements changed over the years, the policies, programs, and structures were changed to meet new challenges. The challenges of the 1980's are here, and changes and improvements must be made to meet the needs for greater efficiency and effectiveness in government. As part of this effort, closer ties between the researchers and implementors are essential, and they must team with the program offices to deliver new solutions to the Nation's highway problems. As DuPont Vice President Robert Hersey has observed, "Research per se is not a suitable objective. Research and its application, taken together and viewed as inseparable, are the legitimate goal." (*10*) This must be the goal for the FHWA R&D program in the 1980's.

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Demonstration Projects Program

by
Douglas A. Bernard

Introduction

To receive maximum benefits from the results of large-scale research and development efforts, the results must be implemented quickly and widely. Often the most promising highway research results never become operational, not because of any inherent inadequacy of the research but because the field engineers do not have the time and resources to analyze useful research and translate it into operation. Also, to accelerate the implementation of research results, those engaged in research must communicate well with those engaged in administering operational programs. One effective means of improving this communication is to show, by an actual demonstration, how the results of research can be applied to an actual operational situation.

The demonstration project activity has a long history in the Federal Highway Administration (FHWA). The construction of projects under the Object Lesson Roads Program around the turn of the 20th century forcefully demonstrated the "seeing is believing" philosophy. The science of highway engineering gradually developed as a function of laboratory research and through a continued program of incorporating experimental features into highway construction and then observing performance under traffic. Historic examples include test road projects in Illinois and California, the Bureau of Public Roads test track in Arlington, Virginia, during the early 1920's, and post-World War II test roads in Maryland, Idaho, and Illinois. (*1*)[1]

In an effort to continue to analyze and translate research results and improve communication by demonstrating the results, FHWA established the Demonstration Projects Program in 1969. The prime objective of the Program was to promote and accelerate the widespread adoption and use of practical highway research results and their application to innovative planning, engineering, and construction practices. (*2, 3*)

[1] Italic numbers in parentheses identify references on page 159.

Program Location

The Demonstration Projects Program is organizationally located in the Eastern Direct Federal Division (EDFD), Region 15, the designated principal field office responsible for administration of the Program. (*4*) To properly analyze and appreciate this relationship, the overall mission of FHWA, which includes the administration of a Direct Federal Projects Program, must be considered. Part of FHWA's activities in fulfilling its mission include providing transportation agencies throughout the United States with knowledge of the state of the art in the planning, design, construction, operation, and maintenance of highways and appurtenant facilities. FHWA has been recognized as an organization which has one of the best, if not the best, technology transfer efforts within the Federal Government.[2] This technology transfer requires engineers trained in the many highway engineering disciplines who must recognize research and development products or innovative practices that may improve current practices. The Demonstration Projects/Direct Federal Program relationship does much to provide and maintain this required high level of expertise.

Demonstration Projects/Direct Federal Program relationship

EDFD, Region 15, provides an excellent training ground for engineers, not only for those in the formalized FHWA training program but for others at various career stages. The inservice training program can be expanded to give specialized design and construction experience to selected engineers as part of a career development program. They learn the physical and personnel problems dealt with by State transportation agencies, as well as gain technical expertise in particular areas of interest. Their firsthand experience is invaluable in their future administration of the Federal-aid Program.

Direct Federal keeps abreast of, or ahead of, the state of the art in highway engineering. Several items included in the Demonstration Projects Program were conceptualized and developed by engineers in Direct Federal. Also, new research technology can be applied in an everyday "production" environment. EDFD, Region 15, like State highway agencies, provides a good testing ground for the practicality of new technology to be demonstrated and an opportunity to "debug," as necessary, before demonstrating it to other agencies.

The successful demonstration of new technology to other agencies must show that the technology can be applied by the level of personnel employed by the agency. The ability of EDFD, Region 15, engineers and technicians to relate to the highway department personnel through "peer communication" has been invaluable in promoting new technology.

EDFD, Region 15, provides an excellent source of staff engineers who collaterally act as demonstration project managers while performing their everyday work assignments. The special areas of expertise, such as geotechnical, materials, hydraulics, photogrammetry, and computer sciences, if not available through the Direct Federal staff, would severely hamper technology transfer efforts in these areas. This dual use of the staff engineers has proven to be an efficient and effective use of personnel.

A successful Demonstration Projects Program requires a high degree of organizational support and flexibility to accomplish the myriad of tasks involved to design, mobilize, and demonstrate new technology. The Demonstration Projects Program has ready access to EDFD, Region 15, in-house support functions including personnel and financial management, administrative services, procurement, and automatic data processing.

Program Operations

The Demonstration Projects Program is administered and operates as a service to the States and their political subdivisions as personnel and funds permit with minimum interference to the administration of the Federal-aid Program and with as few strings attached as possible. New technology included in the Program is promoted on its own merit and no pressure is applied to any agency to adopt or even try the item. This low-key approach generally has been successful.

Technology transfer coordinators in FHWA Region and Division Offices are responsible for letting highway agencies know what is available in the Demonstration Projects Program. When the actual demonstration is ready, an announcement is prepared and issued to highway agencies by the Office of Highway Operations. A project flier also is distributed to advertise and promote the project. In addition, a Demonstration Projects Program notebook is available to all Region, Division, and State Offices. This book periodically is updated with information on the Program's active projects and Program personnel.

Any agency desiring information or a demonstration presentation is advised to contact the FHWA Division Office in their State. That request is then forwarded through appropriate channels to the Demonstration Projects Division with a recommended course of action. Division Offices are urged to assess current agency practices relative to the technology being promoted in

[2] Lee L. Verstandig, Assistant Secretary for Government Affairs, DOT memorandum to Operating Administrator, June 3, 1981.

the project. Only those agencies that have not adopted the new technology for general use would be recommended for a project presentation and technical and financial assistance to construct and evaluate a pilot demonstration installation.

Attempts always are made to honor the requested times for project presentation, however, travel costs and prior scheduled presentations can affect scheduling. In some instances, demonstrations that require the use of traveling vans or tractor-trailer rigs are scheduled on a regional or sectional basis to reduce travel costs.

Organization Structure

EDFD, Region 15, Demonstration Projects Division is subdivided into the Construction and Maintenance Group and the Engineering and Traffic Operations Group (fig. 1).

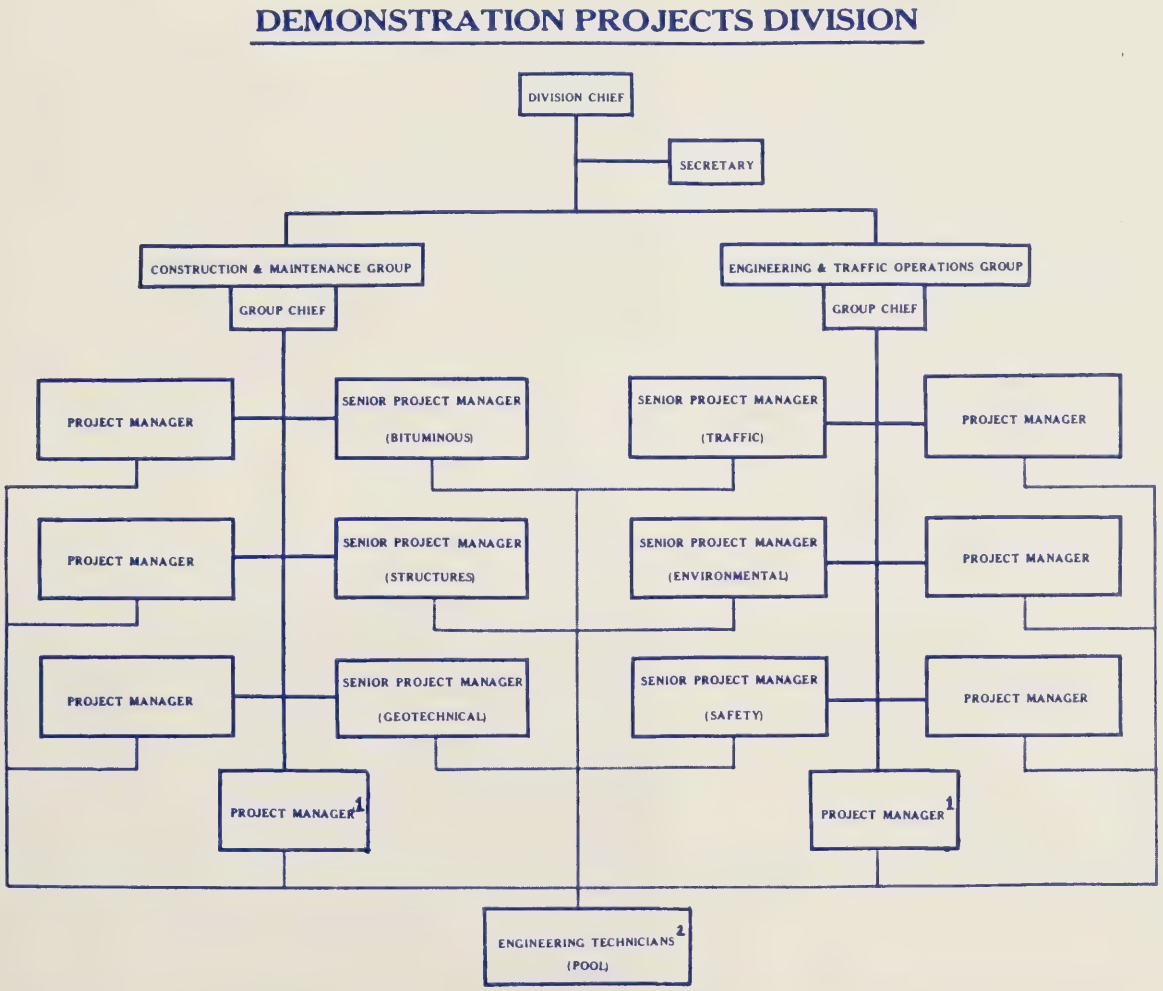
New technology incorporated into the Program is assigned a project name and number. The development, mobilization, and promotion of these projects are assigned to a project manager who generally manages several projects in the same technological area.

In addition to the project managers assigned to the Demonstration Projects Division, personnel with special engineering expertise from other units in EDFD, Region 15, and the Washington, D.C., Headquarters Office are assigned projects to manage as collateral duties. EDFD, Region 15, engineering technicians are assigned to assist in some demonstration projects.

Project Development

A major effort of the Program is to closely monitor potentially promising results of research and

Figure 1.—Demonstration Projects Division.



[1] **Personnel from EDFD or Washington, D.C., Headquarters who are assigned to manage projects as collateral duties.**
[2] **Assigned, as needed, to assist in project mobilization and demonstration.**

development activities that lend themselves to actual onsite demonstrations—promising research items that would require more than written reports to insure ultimate adoption.

Ideas for demonstration projects also are actively solicited from various FHWA offices, State and local highway agencies, and private industry.

When technology with potential for demonstration is identified, a project proposal is prepared. This proposal briefly describes the new technology, the current status of research and implementation efforts, the proposed method of demonstration, the expected benefits, proposed schedules, and estimated funding. The project proposal is circulated for comment to the Interoffice Review Group (IRG, described on page 136 of this issue) (*5*), other FHWA Washington, D.C., Headquarters Offices, and all FHWA Regions. Upon acceptance of the proposal by these offices, a project manager is selected and a technical advisory committee (TAC) is formed. The TAC assists the project manager in the development of the demonstration project, monitors the project mobilization and activity, and keeps the respective program offices informed.

The TAC's generally consist of representatives from the offices included in the IRG and offices having interest or expertise in the particular area, including the Offices of Research, Development, Highway Operations, Engineering, and Environment. Also, if a particular expertise is identified at the State highway or transportation department level, staff is invited to brief the TAC on the particular item and the State's experience. The TAC and project manager then complete a work plan setting forth the objective, scope, and details of the project such as method of demonstration, equipment needed, funds required, and a development and implementation schedule, which is detailed and covers all phases of activities. Assuming all systems are GO, the project is then developed and mobilized.

Kinds of Demonstration

As the Demonstration Projects Program evolved into a nationally accepted medium of technology transfer, three distinct demonstration methods evolved.

Hands-on demonstration

The first method is an on-the-job, "hands-on" demonstration of the use of newly developed equipment and techniques. This method was used to demonstrate projects on air, noise, and water pollution. Several pollution monitoring devices varying in sophistication and price were transported by van

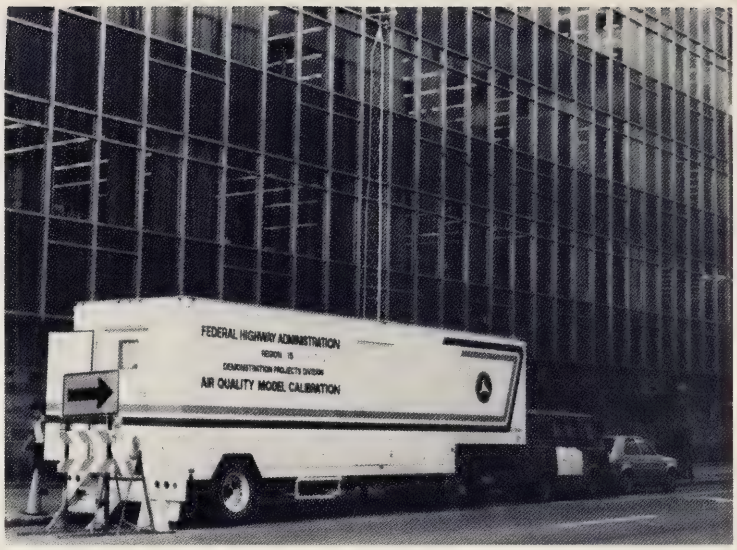


Figure 2.—A demonstration project trailer stationed in an urban environment to demonstrate the use of various equipment to collect, monitor, and forecast levels of air pollution.

around the United States and demonstrated under actual on-the-job conditions to requesting agencies (fig. 2). The vans, in addition to transporting the equipment, served as on-the-job laboratories. Each had on board minicomputers to aid in the rapid processing and analyzing of collected data. Use of these computers also was demonstrated. Because of the demonstrations, agencies could better understand the uses of the pollution monitoring devices and were in a better position to decide the kind and size of equipment to purchase to best suit their needs. Demonstration projects on measurement of pavement skid resistance, urban traffic systems, and hydraulic energy dissipators (fig. 3) also used this hands-on method.

Figure 3.—Demonstration of scour prevention and energy dissipation at culvert outlets with aid of a portable hydraulic flume.

Figure 4.—Project manager conducting a workshop training seminar.

Workshop training seminars

A second demonstration method, workshop training seminars, is conducted on-the-job or in the classroom, depending on the technology involved (fig. 4). An engineer, at times accompanied by engineering technicians, conducts the workshop and training sessions. Demonstration projects on quality assurance using statistical specifications, fiberglass roving for ditch erosion, improved inlets for highway culverts, hydraulic design of energy dissipators, and reduced seasonality of hot plant-mix bituminous paving were conducted as workshop training seminars.

Figure 5.—Attendees at an on-the-job demonstration workshop seminar observing the preparation of "asphalt rubber" before its application on the road.

Pilot demonstration installations

A third demonstration method involves constructing a project incorporating the promoted technology. Technical and financial assistance are provided for the design, construction, and performance evaluation of a pilot demonstration installation. Examples of this method include demonstration projects on open-graded friction courses, asphalt emulsions, sulfur extended asphalt, and the very popular project, recycling of asphalt pavements.

Project Presentations

The number of project presentations—either equipment hands-on demonstrations, workshop training seminars, or pilot demonstration installations—conducted for any agency depends on the need to achieve *Statewide* adoption and implementation of the new technology and the availability of Program funds.

Although it is highly desirable to demonstrate the use of new technology to all State and local highway agencies, limited resources make this impossible. Therefore, when a project is scheduled for presentation, it is recommended that all neighboring highway agencies be invited to attend. To achieve maximum project exposure of new technology being incorporated into a pilot demonstration installation, on-the-job demonstration workshops and seminars are recommended (fig. 5). Highway agencies in the State and in surrounding States can witness firsthand the application and use of the new technology being demonstrated. These demonstration workshops provide a highly efficient and effective means of technology transfer.

All pilot demonstration installations must have performance evaluations. Reports of these evaluations and the construction techniques are valuable to the participating agency and help promote the techniques to other agencies that are skeptical of the new technology.

Program/Project Evaluation

The Demonstration Projects Program was evaluated to support its current and future budgetary requests, improve the data base on which to make program management decisions, and assure that the Program was being effectively administered. This evaluation, completed in 1980, was a coordinated effort between the Demonstration Projects Division and the Administration Division of EDFD, Region 15. (*6*) The evaluation found that the Demonstration Projects Program had been an effective agent for incorporating new technology into the activities of highway transportation departments and recommended that a continuing evaluation process be implemented. The recommendation was implemented in Fiscal Year 1981.

The process requires a short and long term evaluation of each project. A short term evaluation is made when all participants attending a demonstration presentation complete a form. These critiques enable the project manager to fine-tune the presentation to assure a quality delivery process. The long term evaluation, conducted at the completion of each project, measures the effectiveness of the promotional efforts—was the project successful in effecting change?

A second evaluation of the Program was conducted in Fiscal Year 1981 by the FHWA Office of Management Systems as part of a nationwide study on the effectiveness of FHWA's overall Technology Transfer Program. (*7*) This evaluation again concluded that the Demonstration Projects Program had a good reputation and was well received. The one recommendation of the evaluation was that the Demonstration Projects Program should document to the field policy on project participation. This recommendation was implemented in October 1981.[3]

Summary

Since the establishment of the Demonstration Projects Program, many projects have been successfully demonstrated. Because of this Program, several highway agencies now are using newer and better methods to provide a safer, more economical, energy efficient, and environmentally acceptable transportation system.

The adoption and application of demonstrated technologies such as open-graded friction courses, sprinkle mixes, concepts for improving traffic safety through construction and maintenance zones, and urban traffic system improvements have resulted in reducing the number and severity of traffic accidents and highway fatalities.

As highway costs continue to increase, funds must be stretched to meet current needs. One solution to this problem is to use the most efficient and cost-effective methods to design and construct improvements. Demonstration projects responsible for the adoption of such techniques as the Roadway Design System (RDS), Reinforced Earth, hydraulic design of energy dissipators, subsurface investigation, and cathodic protection of bridge decks have contributed to reducing the cost of highway construction.

Efforts to become more energy efficient have been satisfied when demonstrated technologies such as recycling of asphalt pavements, sulfur extended asphalt, and asphalt emulsions have been adopted for use.

Planning, designing, and building highways to be more compatible with the environment have been enhanced by the adoption of demonstrated techniques for estimating, measuring, and abating air, water, and noise pollution.

The Demonstration Projects Program has played a significant role in the adoption in the last decade of much of the new technology. The success of the Program is a tribute to the cooperation received from personnel in the other offices of FHWA's Technology Transfer Program, the hard work and dedication of the personnel assigned to the Demonstration Projects Division and other divisions in EDFD, Region 15, and the personnel in the Region and Division Offices assigned to work with the Program in the field.

[3] D. A. Bernard, Chief, Demonstration Projects Division, memorandum to FHWA field offices, Oct. 26, 1981.

REFERENCES

(*1*) "America's Highways 1776–1976," *Federal Highway Administration, U.S. Department of Transportation,* Washington, D.C., 1976.

(*2*) Administrative Memorandum 1–20, Jan. 8, 1969.

(*3*) "Federal-aid Highway Program Manual," Vol. 6, Chap. 9, Sec. 12, *Federal Highway Administration,* Washington, D.C., June 6, 1975.

(*4*) FHWA Order 1–1, Change 123, item (7), *Federal Highway Administration,* Washington, D.C., Feb. 23, 1981.

(*5*) "Technology Transfer Program," FHWA Order 6000.1, par. 5(b), *Federal Highway Administration,* Washington, D.C., Sept. 6, 1977.

(*6*) Demonstration Projects Evaluation Study, *Eastern Direct Federal Division,* August 1980.

(*7*) Technology Transfer Study, *Federal Highway Administration, Office of Management Systems,* September 1981.

Douglas A. Bernard, Chief, Demonstration Projects Division, joined the Federal Highway Administration in 1962. He served as an area engineer in the District of Columbia and as a highway engineer in the Office of Traffic Operations. His assignment in the Demonstration Projects Program began in 1970 when he served as Chief, Construction and Maintenance Group. Among Mr. Bernard's accomplishments are his influential efforts in the promotion of asphalt pavement recycling.

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NHI—A Leader in Technology Transfer

by
James P. Iverson, Larry E. Jones, and Albert Tappa

Introduction

Section 115 of the Federal-aid Highway Act of 1970 (23 USC 321) authorized the establishment and operation of the National Highway Institute (NHI). The Act directed that NHI ". . . develop and administer in cooperation with the State highway departments, training programs of instruction for Federal Highway Administration and State and local highway department employees engaged or to be engaged in Federal-aid highway work. Such programs may include, but not be limited to courses in modern developments, techniques, and procedures relating to highway planning, environmental factors, acquisition of rights-of-way, engineering, construction, maintenance, contract administration, and inspection." (*1*)[1]

The need for a training arm in the Federal Highway Administration (FHWA) had long been recognized. As far back as 1922, the late Thomas H. MacDonald, as head of the Bureau of Public Roads, now FHWA, expressed a desire to establish a Bureau of Public Roads College to keep practicing engineers abreast of the rapid progress being made in the highway engineering field.

The need to train and retrain engineers, technicians, and other support personnel in the highway community continues to be a critical concern. Public demand for safer highways and better operations coupled with higher costs and lower budgets requires our engineers and administrators, now more than ever, to make critical decisions based on current knowledge of new research and technology. This has made training a major element in the technology transfer movement, and it has made training an essential activity for all disciplines within the highway community.

In fulfilling its legislative mission, NHI maintains a direct and continuous relationship with the program offices of FHWA Headquarters, FHWA field offices, State highway agencies, professional organizations, and colleges and universities. In conjunction with the Demonstration Projects Division, Construction and Maintenance Division, and the Implementation Division of FHWA, NHI supports FHWA's technology transfer program through the development of nationwide training programs. The necessary liaison to promote and conduct such training programs is provided by the designated NHI contact in each FHWA Region, Division, and State highway agency.

As a staff office under the FHWA Administrator, NHI is organized into

[1] Italic number in parentheses identifies reference on page 166.

three functional offices—State Programs, University and Industry Programs, and International Visitors Program. The main technology transfer activities of each office are described in the following sections of this article.

State Programs Office

The State Programs Office is responsible, with the assistance of State highway agencies, for identifying current and future training needs and for coordinating with FHWA program and field offices in developing training to satisfy the identified needs. This responsibility was outlined in the 1970 legislation that created NHI and has remained unchanged.

To accomplish its mission, the State Programs Office develops only training courses that are not readily available from consulting firms or educational institutions and courses that State highway agencies would not ordinarily develop for themselves. With this philosophy as a guide, NHI has geared training course offerings toward topics that involve new and rapidly changing technology. These courses frequently are an integral part of FHWA's overall technology transfer effort to communicate the results of recent research and new technology.

Short courses

Training assistance is provided using two basic formats. The first and most familiar is the development and presentation of short courses (usually lasting 1 to 5 days). The Offices of Research and Development play an important role in the initial course development process. More specifically, the Implementation Division in the Office of Development serves as the bridge between research and the practical application of new technology. Assistance provided by the Implementation Division includes the development of training course materials used by NHI in its course presentations. The predominant method of course development and presentation is by private consultants contracted through competitive bidding. A significant number of courses also are developed in-house and presented using FHWA and State highway personnel as well as university staff members as instructors.

Presentations of a course are made available on a first-come-first-serve basis to highway and transportation agencies by 1- or 2-page "Blue Line" course announcements. A Blue Line, which is issued for each course, describes the course in detail and indicates for whom the course is designed, how to request a presentation, and who in NHI to contact for additional information. The Blue Line is distributed to FHWA Headquarters and field offices, State highway agencies, and other interested organizations. In addition to the individual Blue Line course announcements, NHI publishes a special Blue Line that projects the short courses to be available during the next 18 months. This announcement is updated twice a year.

Training courses generally are available for only 1 to 2 years because of other priority training needs and related budget constraints. However, every effort is made to insure that the training demand is reasonably met and distribution of the presentations is adequate. For example, a course funded for only 10 presentations may be offered to the States on a regional basis to insure each has an equal opportunity to attend. Requests from State highway agencies to host a course are submitted to NHI through the local FHWA Division Office. Local agency requests are submitted through the State highway agency before going to FHWA.

In line with its efforts to provide courses for national distribution, the State Programs Office sponsors special training activities such as seminars and courses tailored to local needs. One example is NHI's sponsorship of an effort by FHWA's Region 7 to develop and present several courses on urban drainage design. These presentations proved helpful to many local agencies in Region 7.

During Fiscal Year 1981, NHI offered 62 different courses and made 386 presentations of these courses to 11,800 participants. Approximately 16 percent of the participants were FHWA employees, 61 percent were State, and 23 percent were local and other agency employees. Figures 1 and 2 reflect the growth of course presentations and the number of participants since 1971. The NHI cost to train each participant has continued to drop over the years. In Fiscal Year 1981 the cost was approximately $80 per participant.

One-half of 1 percent funds

The second format for providing training assistance is through the use of "one-half of 1 percent funds." The 1970 Highway Act (23 USC 321(b)) allowed States to use up to one-half of 1 percent of their urban, primary, and secondary system Federal-aid apportionments for the cost of tuition and direct educational expenses in connection with the training of State and local highway agency employees. These funds are limited to 75 percent of the cost of the training and cannot be used for travel, subsistence, or salaries of course participants. (Higher sliding scale rates are available in Public Land States.) To date 28 States have seen fit to use, in varying amounts, the one-half of 1 percent funding option.

The use of these funds can significantly enhance a State's training effort. The program is basically free of redtape and Federal involvement. The Division Administrator in each State is authorized to approve training programs either annually or as each individual training effort is initiated.

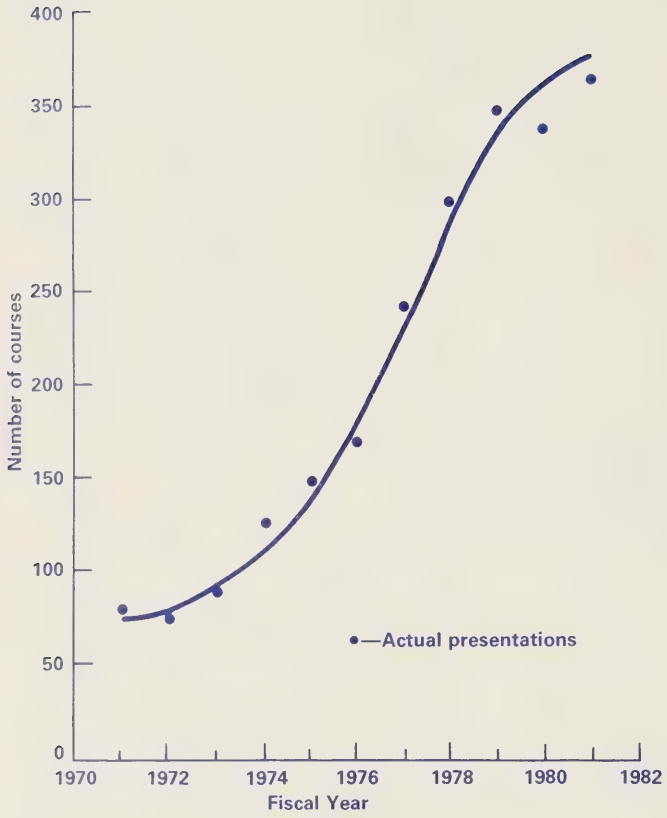

Figure 1.—Growth trend of NHI course presentations per Fiscal Year.

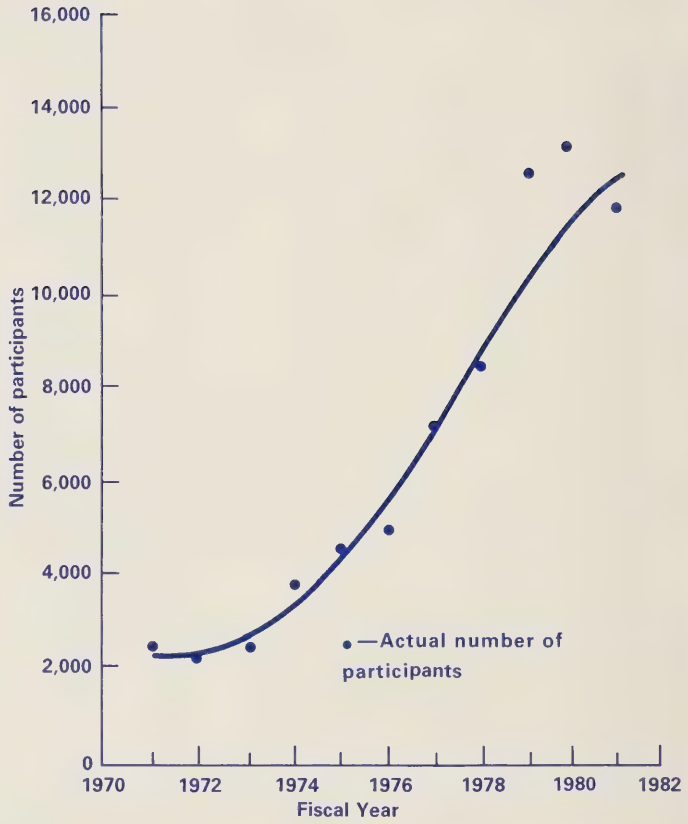

Figure 2.—Growth trends of number of NHI course participants per Fiscal Year.

All of the conventional ways to present training—in-house training, consultant contracts, or public agency agreements—are eligible for Federal funding. Even training equipment that will remain in use by the State is an eligible expense.

Another use of the one-half of 1 percent funds is the purchase from NHI contractors of additional presentations of a given course. At times a State may have a training need that cannot be satisfied by the limited number of presentations available under NHI's contract. When this occurs, the State can obtain the needed training at a very reasonable cost because development costs already have been borne by NHI.

Ongoing and future training

NHI has responded to a variety of training needs since its establishment. In the early and mid-1970's highway agencies were faced with significant budget and staffing cuts, but at the same time more and more Federal and State requirements were being placed on these agencies. The most notable example was the environmental impact legislation. In responding to the training need generated by this legislation, NHI developed a full-scale training effort dealing with various environmental subjects. In recent years the demand for environmental training has been exceeded by such new concerns as inflation, safety, and the desire to better manage the existing transportation system. NHI has responded to these changing needs and offers a number of in-house and contractor instructed courses addressing these topics. Courses in the general areas of construction and maintenance, highway

engineering, planning, safety, traffic operations, environment, right-of-way, and financing are presently available. Some of the more popular courses conducted during Fiscal Year 1981 included Construction Engineering Manpower Management, Design of Urban Streets, Equipment Management Systems, Estimating Highway User Costs, Highway Program Financing, Pavement Management, Practical Applications of Statistical Quality Control, Safety Design and Operational Practices for Streets and Highways, Techniques for Pavement Rehabilitation, and Value Engineering.

Many of the new courses that will become available during Fiscal Year 1982 support FHWA's Program Emphasis Areas—highway safety, cost effectiveness in design and construction, and pavement management. A sampling of course topics to be presented in the near future includes safety evaluation and engineering studies, bridge inspection, design of welded connections, engineering fabrics, traffic signal timing optimization, preconstruction engineering management, construction and rehabilitation of concrete pavements, and traffic network simulation.

University and Industry Programs Office

The University and Industry Programs Office has been heavily involved in technology transfer activities from the time NHI was formed in 1971. In support of NHI's mission, this office promotes technology transfer by working in the following primary areas:

- College curriculum program.
- Lending library.
- Information exchange bulletins.
- Fellowships/scholarships.

One of the most successful technology transfer activities has been the University/FHWA college curriculum program. NHI, acting on a recommendation from the Implementation Division, established this program in October 1975 so that educational materials developed for FHWA-sponsored training courses could be included in the curriculums and short course offerings of technical institutes, colleges, and universities. In the interests of technology transfer and the effective use of Federal funds, this program is intended to extend the benefits that may be derived from dollars already expended to develop training curriculums.

Instructional and student materials from over 40 courses have been made available, and well over 1,000 sets of these materials have been distributed. A recent evaluation of the program revealed that in 1980 alone, the participating schools had used the material to train approximately 6,000 students. Nearly half of these students were employees of highway agencies.

Although the primary target audience of the college curriculum program is schools (over 125 participate in the program), nearly one-third of all requests for material have come from various State and local highway agencies that are conducting their own in-house training activities.

To support the college curriculum program, NHI has attempted to strengthen the working relationship between FHWA, State highway agencies, and the academic community by sponsoring special conferences for college and university faculty, arranging special courses to provide faculty selected curriculum materials, and inviting faculty members to attend NHI course presentations.

It would be impossible to estimate accurately the number of work hours saved in curriculum development as a result of the college curriculum program and its related activities. However, there is little doubt that both the quality and quantity of highway transportation education have improved because of this single aspect of the total FHWA technology transfer effort.

The University and Industry Programs Office operates an audiovisual lending library as an integral part of its overall effort to provide training for employees of Federal, State, and local highway agencies. When new audiovisual materials such as films, slide-tape presentations, and video tapes are developed by the various offices within FHWA, copies are given to NHI for distribution through the lending library. Private organizations also have provided NHI with films and other audiovisual material for distribution through the lending library. Such participation is encouraged by NHI because the diversity of materials available is enhanced. Primary users of the library have been State highway agencies and educational institutions. Approximately 180 titles on various highway transportation topics are available at this time. NHI envisions that the demand for the lending library services will continue to show a steady increase as Federal funds are reduced and highway agencies find it necessary to expand their own training programs.

NHI publishes education and training information exchange bulletins that serve as FHWA's principal means of conveying and exchanging information on various training programs and educational materials related to highway transportation. The bulletins are successful mainly because of the willingness of many others in the highway community, such as highway agencies, trade associations, and educational institutions, to provide information on current technology transfer activities. Materials routinely

announced include short courses, correspondence courses, publications, films, slide-tape presentations, video tapes, and sets of instructional material that may be used by requesting agencies to conduct their own training programs.

The bulletins are distributed to identified contacts in State, city, and county transportation agencies, educational institutions, and private organizations having highway transportation interests. Currently, about 4,000 copies of each issue are distributed. NHI anticipates that these bulletins will serve as an increasingly valuable tool for transferring technology and exchanging information as reduced Federal spending makes it necessary for State and local agencies to do more of their own training.

Another major activity of the University and Industry Programs Office is the administration of a fellowship/scholarship program. This program assists State and local highway agencies in developing needed staff resources through formal education.

An FHWA Notice, issued each September to describe the program and to provide application forms, is distributed to numerous State and local contacts as well as to FHWA offices. The fellowships/scholarships are offered for part-time and full-time study in any discipline needed in the field of highway transportation. Recipients may study at any accredited college or university. To meet the needs of individuals who work in remote locations or who cannot take time away from their jobs to attend regular college classes, scholarships also are offered for correspondence study.

To apply for a fellowship/scholarship, an individual submits the application forms, employer's statement of endorsement, and other supporting information to the local FHWA Division Office for forwarding to NHI for evaluation. Applicants are evaluated by a selection panel representing the highway interests of government, industry, and the academic community. The major factors considered by the selection panel are: the candidate's potential to contribute to a highway agency's transportation program, the objectives of the candidate's study program, relevant experience, and academic and professional achievements. A successful candidate must sign an agreement to work for a public highway transportation agency for a period specified by the kind of award and length of study. For example, a candidate receiving an award for full-time study must agree to work for a period equal to three times the length of the training.

The amount of the award depends on the kind of award, length of study, and level of salary support offered by the employer. The present maximum award is $7,500. Approximately 100 awards were made for study beginning in the fall of 1981.

As a special facet of the fellowship/scholarship program, the University and Industry Programs Office has responded to specialized educational needs of highway agencies by contracting with universities to develop and present intensive graduate level courses on selected topics. Fellowships have been awarded for highway agency employees to attend these courses. Past efforts include the Environmental Management Institute Program at the University of Southern California, the Highway Safety and Traffic Study Program at Northwestern University, and the Public Service Archeology Program at the University of South Carolina. A contract recently was awarded to develop and present a 6-week study program in Pavement Management.

The growth of the fellowship/scholarship program is shown in table 1. Historically, 85 percent of the awards have gone to employees of State agencies, 8 percent to city employees, 5 percent to county employees, and 2 percent to FHWA employees.

NHI recently completed an indepth study of the fellowship/scholarship program. Virtually every FHWA field office and State highway agency participated in this effort. The study confirmed the merits of administering the program at the national level and the significant value of fellowships and scholarships to the continuing education programs of State and local agencies.

International Visitors Program Office

Although seldom thought of in the context of technology transfer, the International Visitors Program is, in fact, one of the prime contributors to the dissemination of highway technology, not only in the United States but internationally as well.

The International Visitors Program provides training and orientation for foreign highway officials and others interested in highway practices in the United States. Annually, NHI develops and conducts academic, on-the-job, or observational training for 400 to 500 international officials. For example, in Fiscal Year 1981, NHI arranged 3,005 workdays of training for 501 road and transportation officials from 52 different countries. Over the past 9 Fiscal Years, programs have been conducted for 4,256 international visitors.

Table 1.—Fellowship/scholarship awards by academic year and program

Academic year	Safety fellowships	Transportation fellowships	Technology scholarships	Environmental Management Institute	Northwestern safety/traffic	Public service archeology	Total
1972–73	12	—	—	—	—	—	12
1973–74	48	22	—	4	—	—	74
1974–75	36	38	56	8	—	—	138
1975–76	42	39	66	9	—	—	156
1976–77	18	43	84	9	—	—	154
1977–78	18	41	73	15	—	—	147
1978–79	19	39	75	15	36	—	184
1979–80	23	39	44	15	19	—	140
1980–81	13	36	58	8	22	10	147
1981–82	11	37	55	—	—	3	106
	240	334	511	83	77	13	1,258

The purpose of the International Visitors Program is twofold: First, it enables top-level highway officials and other highway professionals to receive indepth exposure to the United States; second, and equally important, it enables these professionals to meet and exchange ideas with American colleagues, observe methods and practices, study at academic institutions, and develop the networks of communication that will mean lasting personal and professional ties transcending national barriers. Because the bulk of the training and orientation is conducted at various State highway and transportation departments, technology transfer becomes a two-way street at the grass roots level between international visitors and State engineers, enriching both equally.

Requests for training are made or referred to NHI by organizations such as the U.S. State Department, the Agency for International Development (AID), the United Nations, the World Bank, the International Road Federation (IRF), Foreign Ministries of Transport, various foreign embassies, foreign road and transportation organizations, and by numerous individual engineers wanting to upgrade their own expertise.

The International Visitors Program Office maintains contact with officials in Federal and State highway transportation agencies, local governments, universities, and the private sector to place visitors where their study or training goals best can be met. The visitors generally are interested in such functional areas as:

- Highway planning, design, construction, and maintenance.
- Highway right-of-way and environmental policies.
- Aerial surveys (photogrammetry).
- Bridge design, construction, inspection, and maintenance.
- Laboratory practices and research in structures, materials, and traffic systems.
- Traffic engineering and operations.
- Highway and motor carrier safety.
- Highway financing and administration, including toll roads.
- Highway equipment maintenance, repair, and use.

Requests for training are evaluated and programs are arranged to meet the participant's individual needs. Programs range from 1 day to 1 year or more and may include both university and field training. Field training is provided by FHWA, State highway agencies, and the private sector at no cost to the participant. Costs for university tuition, international and domestic travel, and subsistence are borne by the foreign governments or the sponsoring agencies, such as AID or IRF.

Outlook

NHI strives to identify and respond to current and evolving training needs. During the past year, priorities have been studied and programs adjusted to best match the aims of FHWA, with close

attention to the national emphasis areas. The following guidelines that illustrate the direction NHI will be taking in the near future were developed from internal reviews.

1. NHI will continue to work closely with field offices and State highway agencies to achieve better understanding of and respond to national needs.

2. Greater efforts will be made to deliver the most cost-effective training. Increased use of the "train-the-trainer" approach is anticipated as well as increased use of FHWA's valuable resource of in-house talent to present NHI-sponsored training courses.

3. Greater use of one-half of 1 percent training funds will be encouraged to complement other State training efforts.

4. More fellowship/scholarship funds will be used to provide educational assistance in areas of study consistent with national emphasis areas, such as safety, pavement management, and value engineering.

5. NHI will seek ways of providing additional low-cost, high-yield technological assistance to the highway transportation community by distributing and loaning training materials at no cost to State and local agencies and college faculty, involving college faculty in NHI-sponsored training courses where possible, and encouraging private industry and universities to develop and conduct highway transportation training courses.

6. NHI will increase its technology transfer efforts under the International Visitors Program by expanding its services to members of the international highway/transportation community who attend government/industry-sponsored meetings and conferences in the United States.

REFERENCE

(*1*) Public Law 91–605, *91st Congress,* Sec. 115(a), p. 10, Dec. 31, 1970.

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Larry E. Jones is a training officer in the University and Industry Programs Office of the National Highway Institute, Federal Highway Administration. Mr. Jones manages contracts with educational institutions for development and presentation of specialized training programs. He also manages NHI's program for providing FHWA-developed curriculum materials to college and university faculty. Prior to his present position, he served overseas for 9 years as the training officer for the FHWA Division Office in Laos.

Albert Tappa is the International Programs Officer in the National Highway Institute, Federal Highway Administration. He joined FHWA in 1967 after serving as a career officer in the United States Army in World War II and the Korean and Vietnamese conflicts. During his military service, he lived in or visited some 35 different countries in the performance of his military intelligence duties. Prior to his present position, he worked as a personnel staffing specialist in the Office of Personnel and Training.

Additional information on NHI and technology transfer can be obtained by contacting the FHWA Regional Offices (see page 178) or

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Experimental Projects Program

by

Paul E. Cunningham,

Roger Goughnour,

and Ed Jastremski

Introduction

The Experimental Projects Program administered by the Experimental Projects Branch is under the jurisdiction of the Construction and Maintenance Division, Office of Highway Operations, Federal Highway Administration (FHWA). Performance and cost effectiveness of experimental features are evaluated. National Experimental and Evaluation Program (NEEP) projects and Non-NEEP projects are part of the Experimental Projects Program.

The Experimental Projects Program provides technology and data flow through FHWA technical advisories, NEEP progress reports, national experimental projects tabulations, and construction and material specifications formulation.

In its simplest form, the Experimental Projects Program involves field trials of ideas, methods, practices, or products from any source and evaluates projects whenever economic or cost effectiveness data are desired to respond to highway needs and provide a service to field offices, States, operating units within the Washington, D.C., Headquarters, and local governments.

Background

Originally, the Experimental Projects Program was identified with the Office of Research (1959), with coordination of the Program the prime responsibility of the Office of Engineering. In 1962, the Program was completely placed within the Office of Research, but in 1968, prime responsibility for the Program was returned to the Associate Administrator for Engineering and Traffic Operations. The Program was subsequently reevaluated and revised to reflect updated requirements and criteria, simplifying the administration of experimental features on construction projects and emphasizing the implementation of research findings through this Program. NEEP and the Regional Evaluation Action Program (REAP) resulted as special categories of experimental projects from this reorganized Experimental Projects Program.

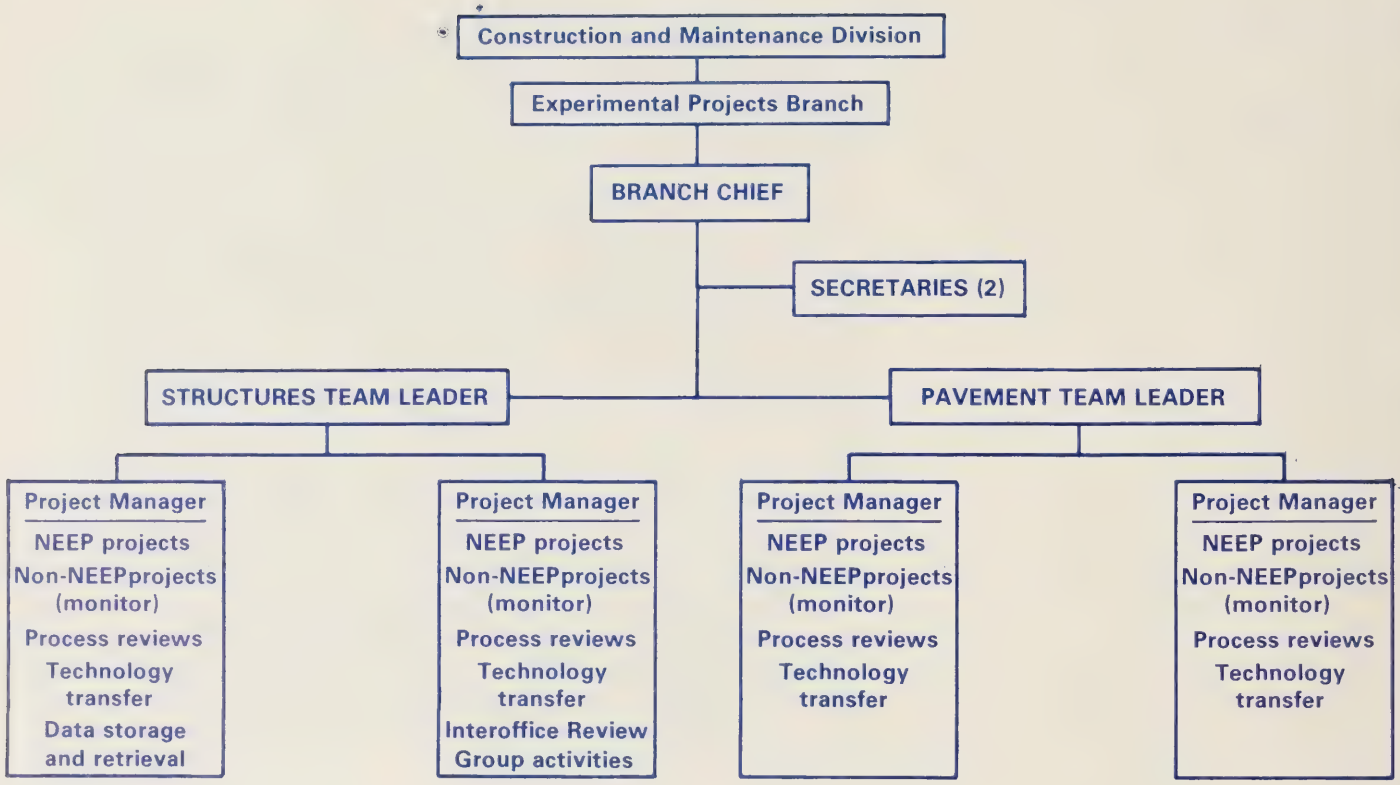


Figure 1.—Experimental Projects Branch organizational structure.

Organization

The Experimental Projects Branch is structured to flexibility and diversification to meet present and future needs. Functions are defined within a Structures section and a Pavement section, with a team leader in each section (fig. 1). Technology transfer activities have been identified as a primary responsibility of the Branch.

Experimental Projects

The purpose of the Experimental Projects Program is to determine if previously researched, field-tested, or documented materials, techniques, or equipment can be adopted for standard use in highway construction. Experimental features are incorporated in Federal-aid highway construction projects to determine the suitability of the features as regular construction items. (*1*)[1]

Work plans, implementation guidelines, and field evaluations performed in a relatively short period determine the merits of the experimental feature, which can be positive or negative, or recommendations can be made. Results are distributed nationally to avoid duplication of effort and provide information beneficial to all interested parties. Experimental feature results serve as a means to incorporate the results into State specifications, standards, or other documents.

Routine experimental projects generally are evaluated visually, and minimum paperwork is required. Projects associated with the Highway Planning and Research Program (HP&R) involve more sophisticated evaluations, including instrumentation and analysis

[1] Italic number in parentheses identifies reference on page 172.

procedures. HP&R projects provide new field evaluations where needed and promote verification of promising research findings. During construction, the need for additional research on highway methods and materials often becomes evident.

When an HP&R study, Implementation Division activity, or an Eastern Direct Federal Division (EDFD) demonstration project is involved with an experimental project, the work is coordinated with the Offices of Research and Development and EDFD.

NEEP Projects

This program is designed to encourage the construction of particularly promising experimental features through the evaluation of existing products, methods, or practices on Federal-aid construction projects. FHWA Regions generally are asked to encourage at least one State in each Region to participate in the evaluation program. NEEP projects are expected to have broad or national application. These high interest or high priority national emphasis area projects are conducted over a short period, usually 2 to 3 years. NEEP is managed by the Experimental Projects Branch.

The following general plan is used to focus efforts on NEEP projects.

1. Preliminary evaluation made of an experimental feature—promising results of research or new products, methods, or procedures.

2. Washington, D.C., Headquarters FHWA technical advisory committee established to further evaluate the experimental feature.

3. Project prospectus with test and evaluation parameters developed for issuance to FHWA field offices.

4. Memorandum sent to the field with prospectus guidelines encouraging one or several States in each Region to establish a NEEP project or projects of limited extent.

5. Reports on NEEP project forwarded to the Office of Highway Operations for overall national coordination and analyzed by the Headquarters technical advisory committee.

6. Status reports issued on all NEEP projects.

7. Final summary reports prepared on each NEEP project by the Office of Highway Operations, with the assistance of other appropriate FHWA offices. These reports include conclusions and recommendations so that all States can profit from the national evaluation, whether they participated in the experiment or not.

In all programs, work plans or guidelines are prepared for the particular experiment. Participating States are encouraged to follow the basic work plan to obtain a simultaneous review in an attempt to evaluate an experimental feature under close, similar conditions over approximately 2 years.

The status of current NEEP projects is shown in table 1.

Table 1.—Current NEEP projects

Project No.	Title	Project status
10	Reducing Reflective Cracking in Bituminous Overlays	Final report in preparation
12	Bridge Deck Protective Systems	Continuing evaluation
16	Epoxy Coated Reinforcing Steel	Continuing evaluation
17	Evaluation of Breakaway Cable Terminal for Roadside Guardrail With Other Guardrail Terminals	Final report in preparation
18	Cathodic Protection on Bridge Decks	Continuing evaluation
20	Experimental Pavement Construction Using Econocrete	Final report in preparation
21	Noise Insulation of Private Dwellings	Final report in preparation
22	Pavement Recycling	Project active
23	Highway Advisory Radio	Project active
24	Use of Incentives and Disincentives	Project active
25	Concrete Overlays	Project active
26	Use of Sulfur as an Extender to Asphalt Binder in Highway Construction	Project active
27	Portland Cement Concrete Pavement (PCCP) Joint Restoration and Rehabilitation	Project active
28	Pavement Drainage	Project active

Currently planned NEEP projects include:

NEEP No. 29—Rapid Testing Procedures on Bridges.
NEEP No. 30—Application of Fabrics in Highway Construction.
NEEP No. 31—The Evaluation of Prestressed Precast Concrete Deck Forms.
NEEP No. 32—Alternate Bidding Procedures for Pavement Type Selection.
NEEP No. 33—Epoxy Thermoplastic Pavement Markings.

REAP Projects

This program is similar in intent to NEEP except that it encompasses a regional effort and is designed to evaluate experimental and demonstration features or existing methods and practices that may be unique to a particular Region. REAP projects fall in the broad category of Non-NEEP projects.

The Experimental Projects Branch responsibilities for Non-NEEP projects include:

- Serving as the coordinating office for all policy decisions regarding acceptance or rejection of experimental features.
- Providing assistance to FHWA Regional Offices on management of the Experimental Program to increase the efficiency and effectiveness of the Program.
- Operating the experimental data storage and retrieval system.

Approvals

Procedures in the Experimental Projects Program have been simplified to the maximum extent. As an example, the FHWA Division Administrator has the authority to approve all experimental projects. (*1*) The Division Administrator also can terminate the projects at any time it is determined that the evaluation goals have been achieved.

Reports

Reports for experimental features can be obtained by any means acceptable to the Division Administrator. In some field offices, the requirements are met by additional comments on the construction inspection report and also the completion of FHWA Form 1461 "Experimental Project Report" (fig. 2). This form is completed annually and forwarded to the Experimental Projects Branch in Washington, D.C., Headquarters for subsequent inclusion in the computerized data file. Two of the Branch's major efforts have been the development of a computerized file for experimental data and annual publication of the "National Experimental Projects Tabulation," which includes a summary of the experimental data on the computer file and provides the mechanism for the dissemination of information to State and local transportation agencies. The computerized data file includes 1,900 experimental projects, including the evaluation of more than 200 construction products. Data files are updated annually with the submission of FHWA Form 1461.

The benefits of an effective evaluation of experimental features are recognized, and the dissemination of this information to interested parties is important. To accomplish this task more effectively, the data storage and retrieval system will be used to identify active experimental applications at the local level. These data eventually will be summarized and distributed to all interested parties.

Technology Transfer

The Experimental Projects Branch provides staff support for the Interoffice Review Group (IRG, described on page 136 of this issue) through the IRG Newsletter, correspondence, summaries, minutes of meetings, permanent secretary responsibilities, coordination of reports, and statements and support to several transportation associations. Planned technology transfer activities include:

- Developing a slide and oral presentation that describes the functions and activities of the Experimental Projects Branch.
- Developing a plan to more effectively evaluate experimental features incorporated in Federal-aid projects.
- Gathering specific cost and performance data on fast-setting concretes, emulsions, fly ash, sprinkle treatments, and glare screens.
- Coordinating activities with the Transportation Research Board, the National Cooperative Highway Research Program, the American Association of State Highway and Transportation Officials, the American Road and Transportation Builders Association, the Association of General Contractors, the National Highway Institute, the Implementation Division, and the Demonstration Projects Division.

RCS HHO-30-19

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO. [1] STATE YEAR – NUMBER SUF.

CONSTRUCTION PROJ. NO. [8]

LOCATION [28]

EVALUATION FUNDING [48]
1 ☐ HP&R 3 ☐ DEMONSTRATION
2 ☐ CONSTRUCTION 4 ☐ IMPLEMENTATION

NEEP NO. [49]

PROPRIETARY FEATURE? [51]
☐ YES ☐ NO

SHORT TITLE

TITLE [52]

THIS FORM

DATE [140] MO. YR.

REPORTING [144]
1 ☐ INITIAL 2 ☐ ANNUAL 3 ☐ FINAL

KEY WORDS

KEY WORD 1 [145]

KEY WORD 2 [167]

KEY WORD 3 [189]

KEY WORD 4 [211]

UNIQUE WORD [233]

PROPRIETARY FEATURE NAME [255]

CHRONOLOGY

Date Work Plan Approved: MO. YR. [277]

Date Feature Constructed: MO. YR. [281]

Evaluation Scheduled Until: MO. YR. [285]

Evaluation Extended Until: MO. YR. [289]

Date Evaluation Terminated: MO. YR. [293]

QUANTITY AND COST

QUANTITY OF UNITS *(Rounded to whole numbers)* [297]

UNITS [305]
1 ☐ LIN. FT. 5 ☐ TON
2 ☐ S.Y. 6 ☐ LBS.
3 ☐ S.Y.-IN. 7 ☐ EACH
4 ☐ C.Y. 8 ☐ LUMP SUM

UNIT COST *(Dollars, Cents)* [306]

AVAILABLE EVALUATION REPORTS

☐ CONSTRUCTION ☐ PERFORMANCE ☐ FINAL [315]

EVALUATION

CONSTRUCTION PROBLEMS [318]
1 ☐ NONE
2 ☐ SLIGHT
3 ☐ MODERATE
4 ☐ SIGNIFICANT
5 ☐ SEVERE

PERFORMANCE [319]
1 ☐ EXCELLENT
2 ☐ GOOD
3 ☐ SATISFACTORY
4 ☐ MARGINAL
5 ☐ UNSATISFACTORY

APPLICATION

[320]
1 ☐ ADOPTED AS PRIMARY STD.
2 ☐ PERMITTED ALTERNATIVE
3 ☐ ADOPTED CONDITIONALLY
4 ☐ PENDING
5 ☐ REJECTED
6 ☐ NOT CONSTRUCTED

(Explain in Remarks if 3, 4, 5, or 6 is checked)

REMARKS

[321]

[700]

FORM FHWA 1461
(REV. 8-79)

Previous Editions are Obsolete

Figure 2.—Experimental Project Report, FHWA Form 1461.

REFERENCE

(1) "Federal-aid Highway Program Manual," Vol. 6, Chap. 4, Sec. 2, Subsec. 4, *Federal Highway Administration,* Washington, D.C., Mar. 14, 1980.

Paul E. Cunningham is Chief, Construction and Maintenance Division in FHWA's Office of Highway Operations. He began his FHWA career as a highway engineer trainee and over the years has served as an area engineer, highway engineer, maintenance management specialist, and a branch chief. Mr. Cunningham's principal field of interest is in highway maintenance.

Roger Goughnour is Chief, Experimental Projects Branch, Construction and Maintenance Division in FHWA's Office of Highway Operations. His career with FHWA has included positions as a highway research engineer, a materials engineer, and a geotechnical engineer.

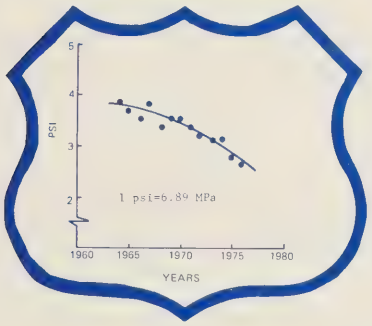
Ed Jastremski is a highway engineer in the Construction and Maintenance Division in FHWA's Office of Highway Operations. He has been involved in the construction and design of highways and structures while with the Maryland Department of Highways, Baltimore County Public Works, and private industry. He started his career with FHWA as an area engineer in Maryland and subsequently transferred to the Washington, D.C., Headquarters Office. Mr. Jastremski is permanent Secretary of the Interoffice Review Group within FHWA's Technology Transfer Program.

Additional information on the Experimental Projects Program and technology transfer can be obtained by contacting the FHWA Regional Offices (see page 178) or

Mr. Paul E. Cunningham
Chief, Construction and Maintenance Division
(HHO–30)
Federal Highway Administration
Washington, D.C. 20590

Recent Research Reports You Should Know About

The following are brief descriptions of selected reports recently published by the Office of Research, Federal Highway Administration, which includes the Structures and Applied Mechanics Division, Materials Division, Traffic Systems Division, and Environmental Division. The reports are available from the address noted at the end of each description.



Pavement Condition Measurement Needs and Methods: Executive Summary, Report No. FHWA–RD–79–67 and Final Report, Report No. FHWA–RD–79–68

by FHWA Structures and Applied Mechanics Division

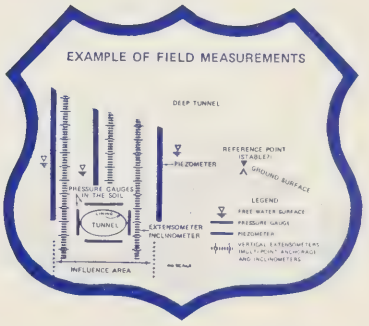
Many State transportation agencies are using highway pavement management systems when making pavement maintenance and rehabilitation decisions. Accurate, current pavement condition data are necessary inputs to an effective pavement management system. For this research study a field review was made of the pavement condition evaluation practices followed in 11 representative State highway and transportation agencies. Each of the selected agencies had instituted a program for making field measurements of pavement condition to be used for scheduling pavement maintenance and rehabilitation. The results of the field reviews documented in these reports show ways that pavement condition evaluation methods vary between States and regions.

The reports treat the four categories of pavement condition data—friction, roughness, structural capacity, and distress. Each category is examined for the type, format, and extent of field measurements required to develop the desired pavement condition data; the various kinds of measurement equipment available and the applications of each; and field data reduction, storage, retrieval, and manipulation methods.

The reports present evaluations of the more widely used measures of the structural capacity of an inservice pavement including load bearing, static deflection, dynamic deflection, impact, and wave propagation. Pavement roughness measuring equipment discussed in the reports includes the direct profiling devices and those devices that provide a "filtered" measure of pavement roughness.

For an optimum pavement condition evaluation system, the reports describe the parameters to be measured, the field procedures to be followed, the preferred equipment for field use, and both the manual and the automated data processing and evaluation methods.

The reports are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22161 (Stock Nos. PB 80 101785 and PB 80 101793).



Representative Ground Parameters for Structural Analysis of Tunnels: Vol. 2, In Situ Testing Techniques, Report No. FHWA/RD–80/013

by FHWA Structures and Applied Mechanics Division

Preliminary subsurface investigations at new tunnel sites allow predictions to be made of the

ground response to the presence of the tunnel opening during and after construction. Ground behavior considerations include the stability of unsupported ground, short term and long term loadings on tunnel supports and tunnel linings, and ground water movement to the tunnel opening.

This report presents a general methodology for subsurface site investigation and evaluates the available in situ field tests for measuring soil or rock properties by geophysical methods. Direct measurement devices and tests applicable in a soil medium include the standard penetration test, cone penetrometer, pressuremeter, vane shear, borehole shear, and the pore water pressure measuring piezometer. Geophysical tests and devices that are useful in a rock medium include the cable jack test, stress relief methods, calipers, dilatometers, and borehole cameras. Indirect geophysical methods described in the report include seismic, resistivity, and magnetic techniques. Large-scale soil and rock testing methods covered in the report are plate bearing tests and direct shear tests. Also provided is a discussion of commonly used drilling and sampling methods that involve larger openings such as shafts, test pits, and pilot bores. Finally, the report describes geophysical engineering classification systems and correlations of soil and rock properties as related to underground design and construction. Included is a review of rock classification methods and their application to the design of primary tunnel supports. Special attention is given to the problems associated with the determination of geotechnical material properties in soil-rock transition zones.

Subsurface site investigations indirectly indicate ground behavior during and after tunnel construction. The distribution of ground materials and the in situ test results, supplemented by visual observations, allow the properties of the ground mass to be estimated. Ground behavior is then predicted on the basis of this information and past experience. Because design and construction in underground space may interact as the tunnel heading progresses, the observed and measured subsurface information is useful for both.

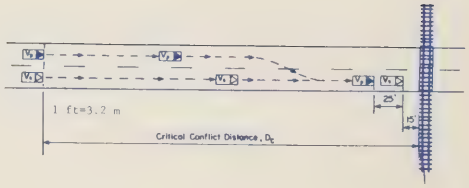
The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22161 (Stock No. PB 81 122038).

Planning and Scheduling Work Zone Traffic Control, Report No. FHWA/RD–81/049

by FHWA Traffic Systems Division

Road construction and maintenance activities often lead to significant disruption of traffic flow. This study developed a planning procedure that highway agencies can use to select objectively the most effective work zone traffic control strategy for a given kind of construction/maintenance activity. From existing data and data collected for this study, quantitative procedures were developed for estimating accidents, delays, stops, fuel consumption, operating costs, air pollution, and cost of traffic control.

The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22161 (Stock No. PB 81 242554).



No-Passing Zone Treatments for Special Geometric and Traffic Operational Situations, Report No. FHWA/RD–81/093

by FHWA Traffic Systems Division

Guidelines for the application of no-passing zone treatments on two-lane rural roads are suggested for intersections, railroad grade crossings, narrow bridges, school zones, developed roadside areas, and transitional sections between two-lane and divided highways. This report contains the results of a limited pilot field test of experimental markings consisting of an advanced dotted line prior to the solid no-passing line to warn passing drivers to return to the right lane before the solid line is reached. Also, the pilot field study tested the NO-PASSING ZONE pennant signs.

Limited copies of the report are available from the Traffic Systems Division, HRS–30, Federal Highway Administration, Washington, D.C. 20590.

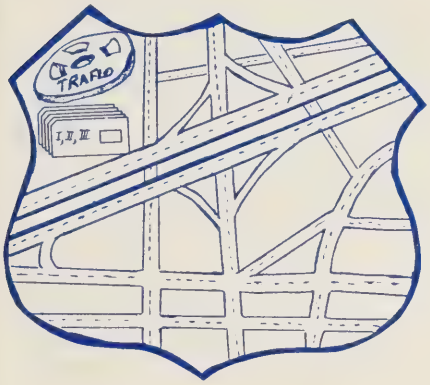
Macroscopic Simulation for Urban Traffic Management: Vol. 1, Executive Summary, Report No. FHWA/RD–80/113 and Vol. 2, TRAFLO User Guide, Report No. FHWA/RD–80/114

by FHWA Traffic Systems Division

The TRAFLO system of models simulates traffic on urban networks and freeways by macroscopic techniques. The TRAFLO system consists of a macroscopic urban

network model called NETFLO, a macroscopic freeway model called FREFLO, and a traffic assignment model. These reports describe the system and provide guidance on its use.

The TRAFLO system allows the representation of traffic in entire urban corridors. This capability provides traffic engineers and planners with a tool for testing and evaluating traffic management strategies that affect sizable portions of an urban street system, including freeways.



Limited copies of the reports are available from the Traffic Systems Division, HRS–31, Federal Highway Administration, Washington, D.C. 20590.

The Effect of Truck Size and Weight on Accident Experience and Traffic Operations, Vols. I–III, Report Nos. FHWA/RD–80/135–137

by FHWA Environmental Division

These reports document a 5-year study of the accident rates of trucks of various sizes, weights, and configurations as well as the traffic operational impacts of these trucks.

In the accident portion of the study, detailed accident data and matching exposure data were collected at 78 road segments in 6 States. Accident rates were then calculated and compared to assess the relative safety of various trucks.

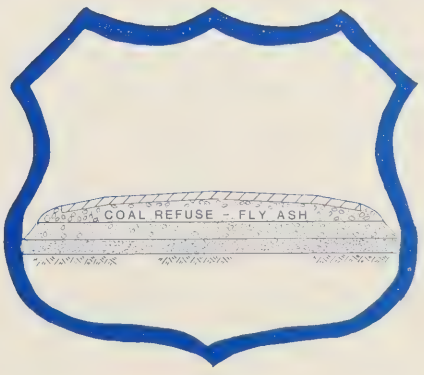
In the traffic portion of the study, 14 sites were selected and instrumented to measure various traffic flow parameters such as speed, acceleration, delay, and closure rate. With this instrumentation, significant differences in traffic flow measures of effectiveness resulting from trucks in the stream were determined as a function of truck size and weight.

Limited copies of the reports are available from the Environmental Division, HRS–43, Federal Highway Administration, Washington, D.C. 20590.

Investigation of the Use of Coal Refuse-Fly Ash Compositions as Highway Base Course Material, Report No. FHWA/RD–80/129

by FHWA Materials Division

The need to recycle waste products is becoming more crucial as the cost of their disposal escalates and the availability of conventional materials becomes scarce. Two such byproducts of the coal industry—coal refuse and fly ash—have shown promise as construction materials. Because of the projected shift from oil to coal for electric power generation, the already abundant supply of both coal refuse and fly ash is expected to increase along with their disposal cost.



This report outlines the findings of a study of the use of coal refuse-fly ash compositions as highway base course material. It includes a discussion of the results from an extensive laboratory testing program on the physical and engineering properties of mixtures of these waste products and a comparison of serviceability index and physical damage parameters based on the VESYS Predictive Design Procedure between crushed stone and coal refuse-fly ash compositions. These findings indicate that substituting stabilized coal refuse-fly ash blends in place of conventional base course material is technically and economically feasible. Inservice use of these stabilized mixtures should now be verified by appropriate field testing. The report also presents procedures for developing design mixes and conducting field tests of coal refuse-fly ash base course material.

The report is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22161 (Stock No. PB 82 101940).

Field Study of Pile Group Action, Report No. FHWA/RD–81/002

by FHWA Materials Division

This is the final report for a study involving the static vertical load testing of a full-scale, instrumented pile group. The test group consisted of nine pipe piles instrumented for settlement, load transfer, pore pressures, total pressures, and inclination. Two similarly instrumented reference (control)

piles also were installed. Two smaller subgroups within the main group also were tested, and uplift tests were conducted on several of the individual piles. The soils at the test site consisted of clays that were overconsolidated by desiccation. Settlement ratios in the working load range varied from about 1.2 to 1.7, depending on the number of piles that were loaded. Failure was observed by plunging of the individual piles. Unit side load transfer varied essentially linearly with depth. Some dependence of load transfer patterns on residual stresses that remained after driving the piles was observed. The measured behavior of the group and subgroups was modeled by the "hybrid" algorithm and by Program PILGP1, which was developed for this study and documented in the Appendixes (Report Nos. FHWA/RD–81/003–008). Computed and measured results agreed when the unit load transfer curves from the reference piles were used and when the soil modulus of deformation was appropriately adjusted to account for pile reinforcement of the soil and the presence of very small strains in the mass of soil around the group.

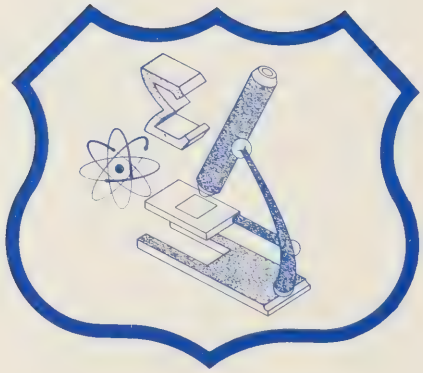
A description of the mathematical model, the rationale for its selection, and a prior analysis of group behavior is presented in the Interim Report (Report No. FHWA/RD–81/001). An analysis of dynamic measurements taken during driving the 11 test piles is found in Report No. FHWA/RD–81/009.

Limited copies of the reports are available from the Materials Division, HRS–21, Federal Highway Administration, Washington, D.C. 20590.

Environmental and Safety Aspects of the Use of Sulfur in Highway Pavements, Vol. I—Evaluation of Environmental and Safety Hazards, Vol. II—Field Evaluation Plan, and Vol. III—Annotated Bibliography, Report Nos. FHWA/RD–80/191–193

by FHWA Materials Division

The use of sulfur in highway paving mixtures has introduced questions about the possible pollutants that may be generated, their environmental impact, and the safety aspects associated with mix preparation and placement. This report presents the results of an investigation in which these factors were assessed.



The study considered the safety and environmental aspects of storage and handling, formulation, construction, operation, and maintenance of highway pavements containing sulfur. These considerations included possible evolution of toxic and obnoxious fumes, dusts, and runoffs. Results of tests simulating inservice conditions such as traffic wear, skidding, freeze thaw, spills, and fires also are discussed. The effects of any emissions on humans, soils, highway structural materials, ground waters, and vegetation are presented. Along with the laboratory study, a detailed work plan that discussed methods and equipment for monitoring potential emissions and recommended safety practices was generated and can be found in Volume II. An annotated bibliography dealing with the safety and environmental effects of sulfur-modified paving materials was also prepared (Volume III).

Limited copies of the reports are available from the Materials Division, HRS–23, Federal Highway Administration, Washington, D.C. 20590.

Implementation/User Items "how-to-do-it"

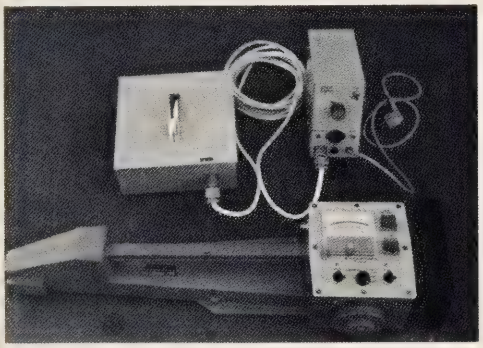
The following are brief descriptions of selected items that have been recently completed by State and Federal highway units in cooperation with the Implementation Division, Office of Development, Federal Highway Administration (FHWA). Some items by others are included when they have a special interest to highway agencies.

U.S. Department of Transportation
Federal Highway Administration
Office of Development
Implementation Division (HDV–20)
Washington, D.C. 20590

Items available from the Implementation Division can be obtained by including a self-addressed mailing label with the request.

Evaluation of Retroreflective Measurement Devices, Summary Report (Report No. FHWA–TS–81–212) and Final Report (Report No. FHWA–TS–81–213)

by FHWA Implementation Division

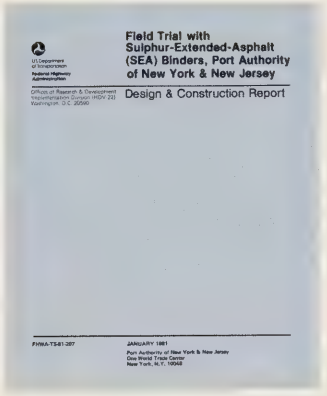


These reports document a study to identify and evaluate devices that measure the retroreflectance of pavement traffic stripes under daylight conditions in the field. Four instruments were identified and evaluated. The study recommends that a new instrument incorporating characteristics of each of the tested devices should be developed.

Limited copies of the reports are available from the Implementation Division.

Field Trial With Sulphur-Extended-Asphalt (SEA) Binders, Port Authority of New York and New Jersey, Design and Construction Report, Report No. FHWA–TS–81–207

by FHWA Implementation Division

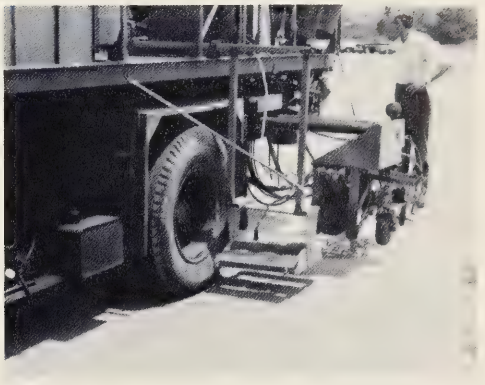


This report is part of a series of reports that describe the procedures and testing used during the design and construction of SEA trial sections. This report examines the feasibility of using SEA binder for roadway pavements. SEA pavement was placed on three cargo area roadways at the Port Authority of New York and New Jersey's John F. Kennedy International Airport. The SEA binder was formulated by separately introducing the asphalt and sulphur to the batch plant's weigh bucket and then mixing in the pugmill with the aggregate (direct mixing). The sulphur/asphalt weight ratio was 30/70.

Limited copies of the report are available from the Implementation Division.

Reflective Marker Paint Stripe Skipper Instruments, Report No. FHWA–TS–81–205

by FHWA Implementation Division

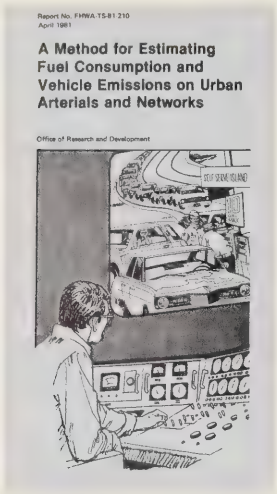


This report summarizes information on the design and testing of two instruments developed by the California and Ohio Departments of Transportation to avoid painting over reflective raised pavement markers. The California instrument optically scans the roadway for reflective surfaces; the Ohio instrument consists of a mine detector type metal sensor to denote the presence of a marker. Both instruments automatically cut off the flow of paint in front of a marker and turn it back on just past the marker.

Limited copies of the report are available from the Implementation Division.

A Method for Estimating Fuel Consumption and Vehicle Emissions on Urban Arterials and Networks, Report No. FHWA–TS–81–210

by FHWA Implementation and Traffic Systems Divisions



This report describes a method for estimating motor vehicle fuel consumption and vehicle emissions in an urban driving environment. The method requires minimum field data collection and processing. The average transient speed as measured by travel time is a good composite parameter and is closely correlated with fuel consumption and vehicle emission rates.

Tables and figures are provided for fuel-speed and emission-speed profiles for a typical mix of passenger cars, single unit trucks, tractor-trailers, and buses.

The report provides a relatively easy and straightforward approach to gain insight into existing traffic operations and the merits of proposed or actual flow improvements.

Limited copies of the report are available from the Traffic Systems Division, HRS–31, Federal Highway Administration, Washington, D.C. 20590.

Federal Highway Administration Regional Offices:

No. 1. 729 Federal Bldg., Clinton Ave. and North Pearl St., Albany, N.Y. 12207.
Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Puerto Rico, Rhode Island, Vermont, Virgin Islands.

No. 3. 1633 Federal Bldg., 31 Hopkins Plaza, Baltimore, Md. 21201.
Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia.

No. 4. Suite 200, 1720 Peachtree Rd., NW., Atlanta, Ga. 30309.
Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee.

No. 5. 18209 Dixie Highway, Homewood, Ill. 60430.
Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin.

No. 6. 819 Taylor St., Fort Worth, Tex. 76102.
Arkansas, Louisiana, New Mexico, Oklahoma, Texas.

No. 7. P. O. Box 19715, Kansas City, Mo. 64141.
Iowa, Kansas, Missouri, Nebraska.

No. 8. P. O. Box 25246, 555 Zang St., Denver, Colo. 80225.
Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming.

No. 9. 2 Embarcadero Center, Suite 530, San Francisco, Calif. 94111.
Arizona, California, Hawaii, Nevada, Guam, American Samoa.

No. 10. Room 412, Mohawk Bldg., 222 SW. Morrison St., Portland, Oreg. 97204.
Alaska, Idaho, Oregon, Washington.

New Research in Progress

The following items identify new research studies that have been reported by FHWA's Offices of Research and Development. Space limitation precludes publishing a complete list. These studies are sponsored in whole or in part with Federal highway funds. For further details, please contact the following: Staff and Contract Research—Editor; Highway Planning and Research (HP&R)—Performing State Highway or Transportation Department; National Cooperative Highway Research Program (NCHRP)—Program Director, National Cooperative Highway Research Program, Transportation Research Board, 2101 Constitution Avenue, NW., Washington, D.C. 20418.

FCP Category 1—Improved Highway Design and Operation for Safety

FCP Project 1I: Traffic Lane Delineation Systems for Adequate Visibility and Durability

Title: Develop a Low-Cost Raised Marker From Epoflex. (FCP No. 31I3053)
Objective: Develop and evaluate a low-cost reflectorized raised pavement marker for temporary situations using Epoflex pavement marking material.
Performing Organization: Southwest Research Institute, San Antonio, Tex. 78284
Expected Completion Date: November 1982
Estimated Cost: $69,000 (FHWA Administrative Contract)

FCP Project 1J: Improved Geometric Design

Title: Shoulder Geometrics and Use Guidelines. (FCP No. 51J2262)
Objective: Establish practical shoulder design and use guidelines from evaluations of existing shoulder designs and research.
Performing Organization: Hugh Downs, Baltimore, Md. 21202
Expected Completion Date: March 1983
Estimated Cost: $100,000 (NCHRP)

FCP Project 1M: Rural Highway Operational Safety Improvements

Title: Driver Needs on Two-Lane Rural Highways. (FCP No. 31M2062)
Objective: Review existing human factor literature to identify human factor limitations. Develop field methods for detecting driver information deficiencies as a function of traffic operational groupings.
Performing Organization: Institute for Research, State College, Pa. 16801
Expected Completion Date: September 1983
Estimated Cost: $590,000 (FHWA Administrative Contract)

FCP Project 1P: Visual Guidance for Night Driving

Title: Safety Considerations in the Use of Commercial Electronic Variable Message Signage. (FCP No. 21P2054)
Objective: Determine the impact of these signs on traffic and operator performance for a representative set of sign types and roadway and traffic conditions. Estimate the safety implications for different types of the signs.
Performing Organization: Federal Highway Administration, Washington, D.C. 20590
Expected Completion Date: September 1982
Estimated Cost: $125,000 (FHWA Staff Research)

FCP Project 1V: Roadside Safety Hardware for Nonfreeway Facilities

Title: Breakaway Tunnel Terminal for Single Thrie Beam Barrier. (FCP No. 41V3312)
Objective: Impact test a breakaway terminal that can be attached directly to the end of the single thrie beam barrier.
Performing Organization: California Department of Transportation, Sacramento, Calif. 95805
Expected Completion Date: July 1983
Estimated Cost: $117,000 (HP&R)

FCP Project 1W: Measurement and Evaluation of Pavement Surface Characteristics

Title: Evaluate Friction Requirements for California State Highways In Terms of Highway Geometrics. (FCP No. 41W2134)
Objective: Compare the measured skid numbers for each of several kinds of highway geometry. Determine the variations in skid number between the different kinds of highway geometrics for a given wet pavement accident rate.
Performing Organization: California Department of Transportation, Sacramento, Calif. 95805
Expected Completion Date: September 1984
Estimated Cost: $109,000 (HP&R)

FCP Category 4—Improved Materials Utilization and Durability

FCP Project 4J: Coating Systems for Controlling Corrosion of Highway Structural Steel

Title: Removal of Lead-Based Bridge Paint. (FCP No. 54J1113)
Objective: Identify potential worker safety and environmental impact problems that result from various lead paint removal techniques. Recommend steps for developing new technologies for removing and recovering lead paints.
Performing Organization: Offshore Power Systems, Jacksonville, Fla. 32211
Expected Completion Date: December 1982
Estimated Cost: $75,000 (NCHRP)

Title: Coating for Nonblast Cleaned Highway Metals. (FCP No. 34J3103)
Objective: Evaluate coatings for nonblast cleaned metal surfaces. Review existing technology to identify underprotected surfaces and appropriate coatings.
Performing Organization: Management Technology, Newton, Mass. 02159
Expected Completion Date: May 1984
Estimated Cost: $180,000 (FHWA Administrative Contract)

FCP Project 4K: Cost Effective Rigid Concrete Construction and Rehabilitation in Adverse Environments

Title: Evaluation of Experimental Installation of Silane Treatment on Bridges. (FCP No. 44K3184)
Objective: Test and evaluate experimental field installations of silane treatment on bridges in various sections of the State.
Performing Organization: Louisiana Department of Transportation and Development, Baton Rouge, La. 70804
Expected Completion Date: September 1986
Estimated Cost: $85,000 (HP&R)

FCP Category 5—Improved Design to Reduce Costs, Extend Life Expectancy, and Insure Structural Safety

FCP Project 5H: Protection of the Highway System From Hazards Attributed to Flooding

Title: Design of Rock Riprap for Protection of Encroachments. (FCP No. 35H1000)
Objective: Evaluate present riprap practice. Collect field data on flow in bends. Improve design procedures.
Performing Organization: U.S. Geological Survey, Sacramento, Calif. 95805
Expected Completion Date: September 1982
Estimated Cost: $300,000 (FHWA Administrative Contract)

FCP Project 5K: New Bridge Design Concepts

Title: Application of Adhesives to Bridge Structures. (FCP No. 35K1142)
Objective: Test spliced beams that have been reinforced with a structural adhesive to determine the effect of glue on increasing static strength and extending fatigue life.
Performing Organization: Blunt and Evans, Washington, D.C. 20005
Expected Completion Date: September 1983
Estimated Cost: $143,000 (FHWA Administrative Contract)

Title: Application of Transverse Prestressing to Bridge Decks. (FCP No. 45K3102)
Objective: Determine proper design criteria for transverse prestressing of bridge decks. Explore methods of providing corrosion protection for transverse prestressed tendons.
Performing Organization: University of Texas, Austin, Tex. 78746
Funding Agency: Texas State Department of Highways and Public Transportation
Expected Completion Date: August 1984
Estimated Cost: $175,000 (HP&R)

Title: Rapid Bridge Deck Replacement. (FCP No. 45K3112)
Objective: Evaluate the effectiveness of several structural details and construction procedures for use of precast concrete members for rapid bridge deck replacement.
Performing Organization: Texas Transportation Institute, College Station, Tex. 77843
Funding Agency: Texas State Department of Highways and Public Transportation
Expected Completion Date: August 1984
Estimated Cost: $150,000 (HP&R)

FCP Category 6—Improved Technology for Highway Construction

FCP Project 6D: Pavement Rehabilitation

Title: Evaluate Effectiveness of Portland Cement Concrete Pavement Rehabilitation Techniques. (FCP No. 46D2844)
Objective: Determine relative effectiveness of the various rehabilitation techniques. Optimize particular techniques that will provide the most effective combined strategy rehabilitation for various pavement conditions.
Performing Organization: California Department of Transportation, Sacramento, Calif. 95805
Expected Completion Date: September 1983
Estimated Cost: $100,000 (HP&R)

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FCP Project 6E: Rigid Pavement Design and Construction

Title: Shoulder Rehabilitation Evaluation (Route I–78) to Identify a Cost Effective Means to Upgrade. (FCP No. 46E1534)
Objective: Evaluate several different methods of shoulder resurfacing, restoration, and rehabilitation.
Performing Organization: New Jersey Department of Transportation, Trenton, N.J. 08628
Expected Completion Date: June 1986
Estimated Cost: $24,904 (HP&R)

FCP Category 0—Other New Studies

Title: The Characteristics of Concrete on the Load-Carrying Capacity of Drilled Shafts. (FCP No. 40M1842)
Objective: Investigate the effects of slump on the load-carrying capacity of drilled shafts.
Performing Organization: University of Texas, Austin, Tex. 78763
Funding Agency: Texas State Department of Highways and Public Transportation
Expected Completion Date: August 1983
Estimated Cost: $60,000 (HP&R)

Title: Permafrost Research Site Monitoring. (FCP No. 40M1852)
Objective: Evaluate various experimental features constructed to mitigate thermal changes and roadway movements in areas of discontinuous permafrost.
Performing Organization: Alaska Department of Transportation and Public Facilities, Juneau, Alaska 99801
Expected Completion Date: June 1983
Estimated Cost: $53,000 (HP&R)

Title: Reactive Silane-Coupled Asphalt/Mineral Composites as Binders in Paving Construction. (FCP No. 40M3712)
Objective: Investigate silane-coupling agent behavior relevant to mineral fillers and asphalt. Develop procedures of making composites and using them as binders.
Performing Organization: Arizona Department of Transportation, Phoenix, Ariz. 85007
Expected Completion Date: September 1983
Estimated Cost: $72,000 (HP&R)

Title: Fabric Forms With Cement-Flyash Mixture for Erosion and Sediment Control. (FCP No. 40M4143)
Objective: Determine the characteristics of cement-flyash mixture for erosion control structures and the feasibility of using nylon fabrics as placement forms instead of wood or metal forms.
Performing Organization: Research and Development, Oklahoma City, Okla. 73105
Funding Agency: Oklahoma Department of Transportation
Expected Completion Date: July 1985
Estimated Cost: $88,000 (HP&R)

Title: Evaluation of Rapid-Setting Repair Materials for Concrete Pavements and Bridges. (FCP No. 40M5674)
Objective: Select and evaluate the most promising rapid-curing repair materials for portland cement concrete pavements and bridges. Test in the laboratory to determine mechanical properties and cure times at different temperatures. Test in the field to determine optimum mixing, placement, finishing methods, and performance. Develop a users manual.
Performing Organization: University of Texas, Austin, Tex. 78712
Funding Agency: Texas State Department of Highways and Public Transportation
Expected Completion Date: August 1984
Estimated Cost: $250,000 (HP&R)

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