SHRP-M/UIR-91-521

Strategic Communications and Training Plan

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Strategic Highway Research Program
National Research Council
Washington, D.C. 1990

SHRP-M/UIR-91-521
Contract H-110
Project Manager: *John Hibbs*

June 1991

key words:
delivery systems
environmental
equipment
information
maintenance
materials testing
technology transfer
traffic engineering
training

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Acknowledgments

The research described herein was supported by the Strategic Highway Research Program (SHRP). SHRP is a unit of the National Research Council that was authorized by section 128 of the Surface Transportation and Uniform Relocation Assistance Act of 1987.

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Abstract

This research was conducted in order to develop a strategy to effectively accelerate the transfer of technology being developed in the SHRP highway operations program. Products of each research contractor are identified. Methodology for identifying and analyzing communications and training mechanisms is presented. Results of recent surveys on information dissemination and technology evaluation by highway agencies are summarized. Target audiences are identified. Findings indicate a multi-faceted approach is necessary to reach various audiences with different interests. Recommendations are made regarding use of specific mechanisms for each research product.

Executive Summary

The Strategic Highway Research Program (SHRP) is currently developing new cost-effective technology in highway operations. These research programs are a result of a very focused effort to identify problems in fundamental maintenance areas and develop new and better approaches (e.g. equipment, materials, procedures) for maintenance personnel to use.

The primary objective of the H-110 project is to develop communications and training "products" that will facilitate rapid and effective implementation of the highway maintenance effectiveness and snow and ice control research. In order to meet this objective it was necessary to determine the communications and training products that are the most effective in transferring highway operations technology to end-users. The results of this effort are:

- Identification of the information and training needs of discrete audiences who evaluate and implement new products;
- Identification of the best methods and mechanisms to transfer the various technologies; and
- Recommended approaches to take in developing and implementing communications and training packages.

The research activities undertaken to accomplish the work were as follows:

- Liaison with research contractors and identification of expected results and deliverables;
- Identification of maintenance and operations functions related to the research;

- Determination of information and training needs;
- Identification of existing training material and media; and
- Determination of effective delivery systems and mechanisms.

Expected accomplishments and deliverables for each research project were identified through review and analysis of project documents, and discussions with SHRP, contractor and expert task group personnel. Not all projects have products requiring communications and training packages. Fundamental studies are not intended to have implementable technology and were used only to select topics for further study and development. Other projects which were begun but failed to show promising results have been eliminated. At present there are eleven projects that have potential for providing new technology in the following areas:

- Pavement maintenance (including materials, methods and equipment);
- Work Zone safety devices;
- Storm monitoring and warning systems; and
- Snow and ice control on pavements.

Results of this technology development must be implemented by the intended users. Functional areas within state and local highway agencies having control or influence over implementation of the products have been identified. The methods and systems used by agency personnel have been reviewed and analyzed. The new product evaluation process has been documented and information needs identified. Based on recent surveys by GAO and TRB, most states now have a formal evaluation process as well as some form of technology transfer function which they use to implement improvements.

A survey of the T^2 Centers and other organizations involved in the dissemination of highway technology was made to determine the extent of existing training products on topics of interest. Results of this survey are not complete as we have received responses from only 21 of the 46 centers. Work will continue on assembling a data base of currently available training material relative to SHRP research topics.

A number of delivery systems (methods) and delivery vehicles (media) were identified and analyzed. Since it could cause some confusion to those unfamiliar with formal training terminology, it is important for readers of this report to note the difference between "method" and "media" as we use the terms here and as were dichotomized in the request for proposals. The "method" is how and where the training is delivered (workshop, conference, demonstration, classroom) and "media" is what format the material is delivered in (video, view-graphs, workbooks, instructions, etc.). The most prevalent are listed below:

Delivery Systems (Methods)

- Workshops,
- Networking,
- Newsletters,
- Demonstrations,
- Circuit Rider,
- Conferences,
- Classroom Instruction.

Delivery Vehicles (Media)

- Video Tapes,
- Manuals,
- Briefs,
- News Articles,
- Brochures,
- Computer Programs,
- Films.

All methods and media, either individually or in combination, are useful tools in transmitting information; however, they are not equally cost effective. Consensus among respondents to an NCHRP survey shows that "methods" which promote personal contact are rated high because personal contact is valued as an effective mode of technology transfer. However, personal contact (in the form of a workshop) obviously is not enough by itself. At such a workshop one will need training and informational materials (videos, outlines, etc.). It is concluded that workshops and conferences are the best choices for a delivery system. The best media for the project are video tapes, handbooks, briefs, and news articles.

After considering all information obtained during the review and analysis effort the following conclusions can be drawn:

- Products developed for the dissemination of any new or modified technology need to be broken down into two distinct groups --

  + Information Products. Those mechanisms that assist the highway agency manager or maintenance engineer to make a quick decision to evaluate or implement new technology.

  + Training Products. Those mechanisms that help the agency manager or maintenance engineer implement the technology.

- Not any one delivery system or media/technique will effectively transfer the technology. The use of several mechanisms in combination will accelerate the transfer of information. The selection of approaches must consider the amount of time allowed for transfer (adoption and implementation), and the scope of coverage considered necessary for the technology to be effective.

- The best format for the training material is a function of cost to produce, geographic dispersion of the audience, coverage of the topic, and learning capacity of the audience.

It is recommended that where "training products" are required efforts be concentrated on developing a multi-media "training package" for each subject area, with packages containing an instructor packet with course outlines, video tapes, briefs, copies of articles, handbooks/workbooks, field exercises or demonstrations, and other interactive materials. Where "information products" are required it is recommended that promotional videos, technical briefs and news articles be used. Emphasis should be placed on reaching primary decision makers and implementers in state and provincial highway agencies through methods which promote personal contact such as seminars and conferences. The recommended communications and training products and delivery systems are summarized below:

Primary Delivery Systems	Communications and Training Products	
	Information Products	**Training Packages (Multi-Media)**
• Workshops • Conferences • Demonstrations • Classroom	• Promotional Videos • Technical Briefs • News Articles	• Course Outlines/ Instructor Guide • Training Videos • Handbooks/Workbooks (including guidelines for field exercises and demonstrations)

The number and types of communications and training products that ultimately will be produced depend upon a number of variables. Cost estimates will be made on an annual basis and included in the H-110 annual work plan.

1

Introduction and Research Approach

Introduction

Every year highway organizations spend tremendous sums of money in rebuilding and maintaining the nation's highways. Figure 1-1 summarizes the number of highway miles and dollars spent by the major types of jurisdictions in the United States for 1987. Each agency is responsible for maintaining highways as economically as possible.

The best strategy of accomplishing this goal is to implement new cost-effective technology which improves efficiency and safety. SHRP has been mandated to provide the new technology to assist highway agencies in this effort.

SHRP's highway operations research program is a result of a very focused effort to identify major problems in fundamental maintenance areas and develop new and better approaches (e.g. equipment, materials, procedures) for maintenance personnel to use.

SHRP has included activities that accelerate, as well as facilitate, the implementation of new technology resulting from the research. The Maintenance Worker Training and Implementation Products Project (H-110) focuses its efforts on these activities.

FIGURE 1-1

TOTAL DISBURSEMENT FOR HIGHWAYS (1987)

Jurisdiction	Billions of $
States	$46.305
Counties and Townships	10.577
Municipalities	14.827

MILES OF ROADWAY BY JURISDICTION (1987)

Jurisdiction	Rural	Urban	Total
State	703,554	95,442	798,996
County	1,595,313	86,207	1,681,520
Town and Township	444,803	52,851	497,654
Other Local Roads	208,657	474,643	683,300
Under Federal Control	211,511	1,045	212,556

Source: *Highway Statistics 1987*, U.S. DOT FHWA, FHWA-PL-88-008

Research Objectives and Scope[1/]

The objective of the H-110 project is to develop communications and training products that will facilitate rapid and effective implementation of SHRP's highway operations research which covers two primary areas:

- Maintenance Effectiveness, and
- Snow and Ice Control.

In order to quickly and effectively implement new ideas resulting from this research, materials must be produced to communicate information in many different forms and be organized to provide the greatest impact on end-users.

In Task One two video tapes were developed by the H-110 contractor to provide an overview of the SHRP Program to the entire highway community. These video tapes have received very wide distribution and have been instrumental in getting the message out about SHRP results and upcoming products. Comments by audiences have been favorable. For instance, Leland Smithson (Iowa Department of Transportation) showed the videos to nine groups including the Iowa Chief Engineer, Iowa Research Board, Department of Transportation field engineers, Field Maintenance secretaries, and highway maintenance supervisors, including about 300 people. According to Mr. Smithson, "*About 250 submitted their written comments on the videos. Nearly everyone felt Jorgensen did an excellent job of providing an overview of ongoing research. Many of the highway supervisors are going to show it to their crews. They are ready to test products, methods, and equipment when they are ready.*" The videos have proven to be uniquely effective at quickly and thoroughly delivering the SHRP message."

To further accomplish the contract objective, discrete audiences must be identified and effective delivery systems planned and implemented. The principal objective of Task Two is to determine what types of communications and training products are the most effective in transferring highway operations technology to end-users. The results of the Task Two research study include:

- Identification of the training and information needs of discrete audiences who evaluate and implement new products;

- Identification of the best methods and media to transfer the various technologies; and

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1/ It should be pointed out at the outset that the H-110 Project (Maintenance Worker Training and Implementation Products) is not primarily a research project but a "product" development project. Only about one-half of 1 percent of the available funds were allocated to conduct initial project research in 1990.

- Recommended approaches to take in the development and implementation of training and communication products.

Discrete audiences need to be identified throughout the entire highway operations community, but the primary focus of this study is on state highway agencies. Other organizations which were included in our review and evaluation were city and county public works departments, federal agencies such as the National Park Service and Forest Service, and toll authorities.

The range of technical products requiring technology transfer was limited to the items identified by SHRP's research proposals in the highway operations area. Initially a number of different technologies and products were considered under the fundamental studies. The purpose of these studies was to narrow the field of individual items down to those which showed the most promise in terms of implementability and effectiveness. Although the list of specific products has not been finalized, the types of products are well enough defined to provide a focus for development of a strategy and plan for communications and training products.

The mechanisms studied cover a very broad scope. They include well-known methods as well as new technology-driven activities such as teleconferencing.

Research Approach

The research objective of Task Two was met through a concentrated effort that covered a short time span of six months. These efforts are identified in Section 2 Findings, under the appropriate research activities. References are provided. The research approach followed in the Task Two effort is outlined below.

Liaison With Research Contractors and Identification of Research Products

In order to develop a proposal for the H-110 effort, background information was gathered with regard to the development of the research program for the highway operations area as well as the research that had been undertaken up to June 1989. At that time the fundamental studies for all three of the major topics were still under investigation but recommendations had not been finalized as to the specific products or items which would be investigated in detail and developed for prototype testing and evaluation.

Investigations into the activities of each research contractor were begun in March 1990. At that time, SHRP staff provided the following documents and information to help in identification of research efforts and establish contacts:

- Project Summary Sheets for February 1990, May 1990;
- Project Interim and Final Reports where available; and
- Internal memoranda and notes dealing with progress and status of various research activities.

Contact with research contract personnel was initially established through telephone and facsimile as well as video tape presentations made available by the contractors. During the Highway Operations Technical Advisory Committee meeting of April 19 and 20, 1990 personal contact was established with contractors covering the snow and ice and work zone safety topics. Later at the SHRP Summer Workshop, August 1-3, 1990 contact with personnel in pavement maintenance effectiveness was established.

Through review of the currently available reports and other information on each research project, end products were identified for evaluation and use by highway agencies.

Identify Maintenance and Operations Functions Related to Research

After review and analysis of the individual research contractor's efforts and expected results, we were able to use this information to identify the functional areas within a typical highway organization that make or influence decisions on the evaluation or adoption of a specific technology. A review of organizational structures for fifty state departments of transportation and several selected county and city public works departments was made and resulted in the development of a typical organizational arrangement. This was used as a reference to identify specific functional areas where maintenance products would either be evaluated or used.

A literature search was also conducted to obtain any additional information available with regard to technology transfer of highway maintenance technology, adoption and use of new technology, and research and development efforts in the highway maintenance area.

Several recent studies on these subjects were identified and provided useful information and insight as to the types of highway and public works personnel who receive and act upon new technical information.

Divisions of authority and responsibility within a typical highway organization were identified by reviewing personnel classification statements and job descriptions of five state highway organizations and two county public works departments. A generic personnel categorization was then established listing the various types of personnel who would be targets of the information diffusion process. As a result, discrete audiences for the research products were identified.

Determine Information and Training Needs

Based upon identification of the authority and responsibility of the various personnel categories, information and training needs could then be identified.

Information needs were perceived to cover a broad range of items because of the many different areas within a highway agency where decisions are made and actions initiated. This includes decisions affecting the budget process, resource allocation, and purchasing to name a few. The approach taken was to identify the most common types of information required by these decision makers, such as cost, effectiveness, durability, etc.

This information provided support decisions on:

- Trying a new technology (product or system),
- Determining the approach to take in implementation,
- Documenting back-up funding requests, and
- Restructuring or reorganizing resources.

The training needs fall into two basic categories:

- Training personnel at all levels with regard to a totally new product, technique or system; and

- Training personnel on specific levels with regard to modification of an existing product, technique or system.

Because of the diversity of products being developed by the SHRP highway operations program, the types of training needs must be divided into several different categories. The information required will be product specific. The delivery system will be a function of the type of product being addressed and the audience using each product.

Additional insight was gained from reports which documented studies of the technology transfer and adoption process in highway agencies. These needs are summarized into specific categories such as cost, implementability, operational procedures, and preventive maintenance procedures.

Identify Existing Materials and Media

A review of the currently available training and communications materials in the maintenance area was made. The purpose of this effort was to:

- Identify existing training material relative to the type of technologies being developed;
- Identify communications media that is currently being employed to disseminate information about similar types of technology or products; and
- Evaluate the effectiveness of these efforts.

Information on existing material was solicited from numerous sources. This included federal, state and government organizations, trade associations, universities and private companies. A survey letter was sent to each of the 46 RTAP T^2 centers requesting copies of the catalogs and listings of their currently available courses. Similar requests were made on an individual basis to a number of other organizations. Numerous trade publications were reviewed to identify various mediums used to disseminate information about new products.

Determine Effective Delivery Systems and Media

Using data collected on target audiences, information and training needs, and existing materials and media, appropriate and effective strategies were developed to initiate the diffusion of information and the transfer of technology on each of the SHRP operations research products. These strategies were developed through brainstorming with Jorgensen staff experts, SHRP staff and research contractors. Discussions were held with research contractor personnel in order to determine their past experiences in developing delivery systems for similar types of products. Based on the background information about target audiences, we were able to collectively identify cost-effective approaches to delivering information and training. It is also important to clarify the relationship between existing materials and those materials proposed for the H-110 Project. The primary reason for cataloging existing materials is that some research results may only indicate minor modifications of methods. In this case, existing courses may be useful. However, in most cases since new methods are being developed, new materials will be necessary.

Based on the findings we have been able to develop detailed recommendations for preparing and implementing communications and training products. Findings are described in the next chapter. Conclusions and recommendations are presented in Section Three.

References

1. America's Highways: Accelerating the Search for Innovation, Transportation Research Board Special Report 202, 1984.

2. Strategic Highway Research Program Research Plans, Transportation Research Board, May 1986.

3. Program Announcement, 4th Quarter FY1989, Strategic Highway Research Program, 1989.

2

Findings

Our findings are based on the research approach presented in Section One. They reflect a brief concentrated effort to understand how to present and effectively implement new technology in a highway organization.

The findings of Task Two are presented below under five major headings:

- "Identification of SHRP Highway Operation Research Results,"
- "Characterization of Highway Agency Organizational Structures,"
- "Determination of Information and Training Needs,"
- "Existing Training Material and Information Dissemination Media," and
- "Identification of Effective Delivery Systems."

Identification of SHRP Highway Operation Research Results

SHRP began the highway operations research program in the Spring of 1987 with the release of request for proposals on four of the sixteen prime research contracts originally envisioned. By July 1, 1990 contractors for all of the remaining projects had been selected although negotiations were not complete with regard to Contracts H-106 and H-107. It is understood that these contracts will be finalized so that the researchers can begin work no later than September 1990. In addition to the contracts originally identified in the program, funds were set aside for the development of promising

concepts. These projects are identified as SHRP Ideas and are awarded on an individual merit basis. To date three such projects have been funded within the highway operations program.

Figures 2-1 and 2-2 provide a graphic description of the basic strategy with regard to the prime contracts in this program as well as the SHRP Ideas. The work involved the conduct of fundamental studies in selected problem areas in order to identify specific techniques, materials or equipment that merited detailed investigation and possible prototype development. While not all the topics originally considered will result in new or improved products, a number of improvements will be made to current maintenance practices and new products (materials and equipment) and will be successfully developed and demonstrated.

Because research and evaluation of a number of proposed products is just getting under way, there is no way to identify, at this time, the "winners" and "losers" among all the items being investigated. For example, the H-107 study of Maintenance Work Zone Safety identified 25 specific devices that show promise for improving safety conditions within a maintenance work zone and/or reducing costs. All 25 devices are scheduled for prototype development, testing and evaluation. As part of Contract H-108, results will show that while some of these ideas are certainly effective, some may be neither practical nor cost effective.

Although not all research will result in an implementable product, we have taken the approach here that information dissemination and training may be required for any of the items initially identified in the research contractor's scope of work. Figure 2-3 therefore identifies the topics being investigated by each contractor and end-products which are anticipated as a result of the research effort.

Characterization of Highway Agency Organizational Structures

Two types of organizations were identified as the agencies representing the vast majority of highway operations within the United States. State highway departments and administrations make up the largest organizational group in terms of responsibility for traffic volume and budget. The other type of organization is the local (city or county) public works department. While there are many more of the local organizations than the 50 state highway departments and their road mileage is larger, their traffic volume is considerably less and their aggregate budget is about half the total of the 50 states. These local organizations do play a significant role in developing and maintaining the

FIGURE 2-1

Work Flow for Maintenance Cost Effectiveness Contracts

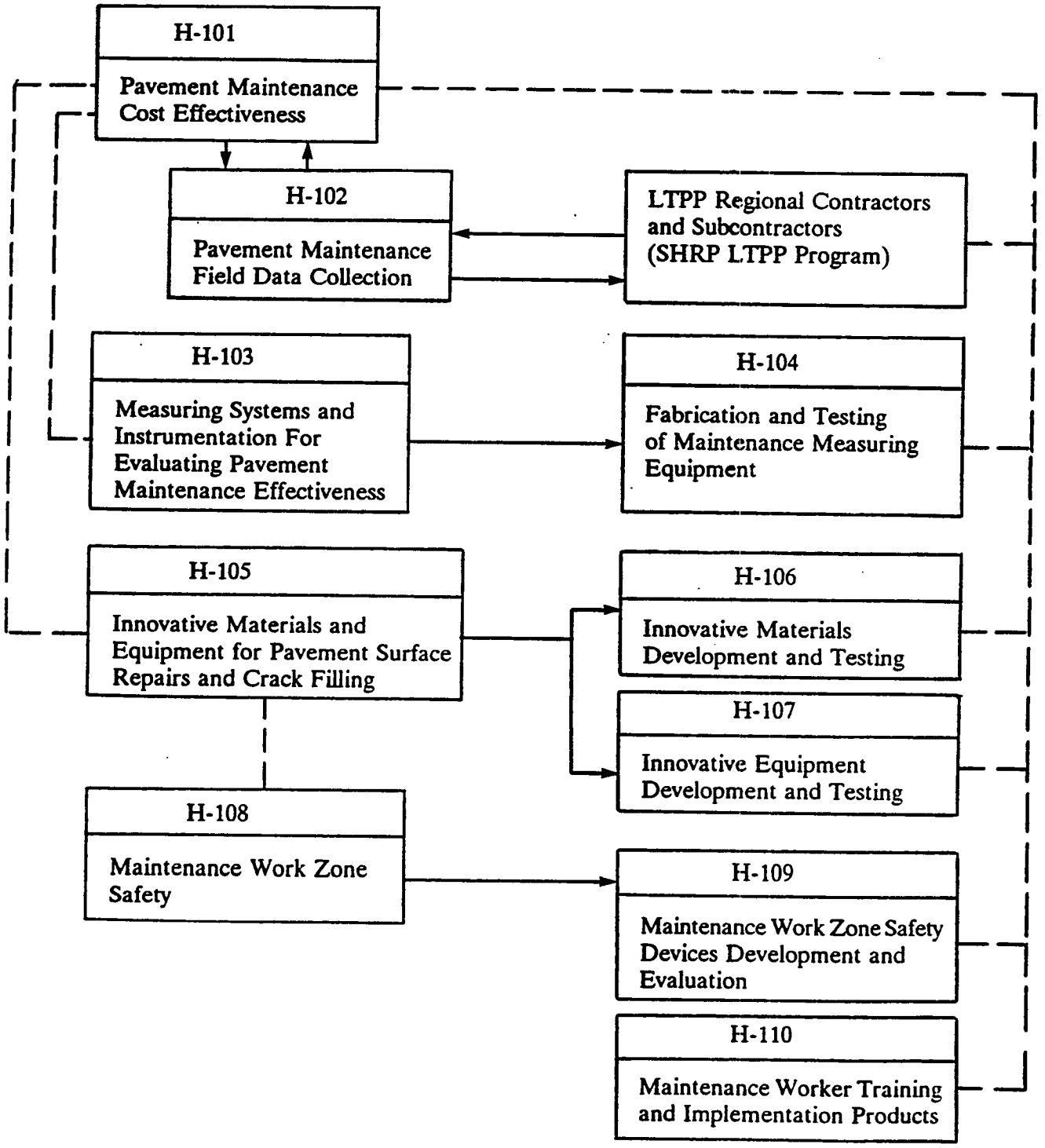


FIGURE 2-2

Work Flow of Snow and Ice Control Contracts

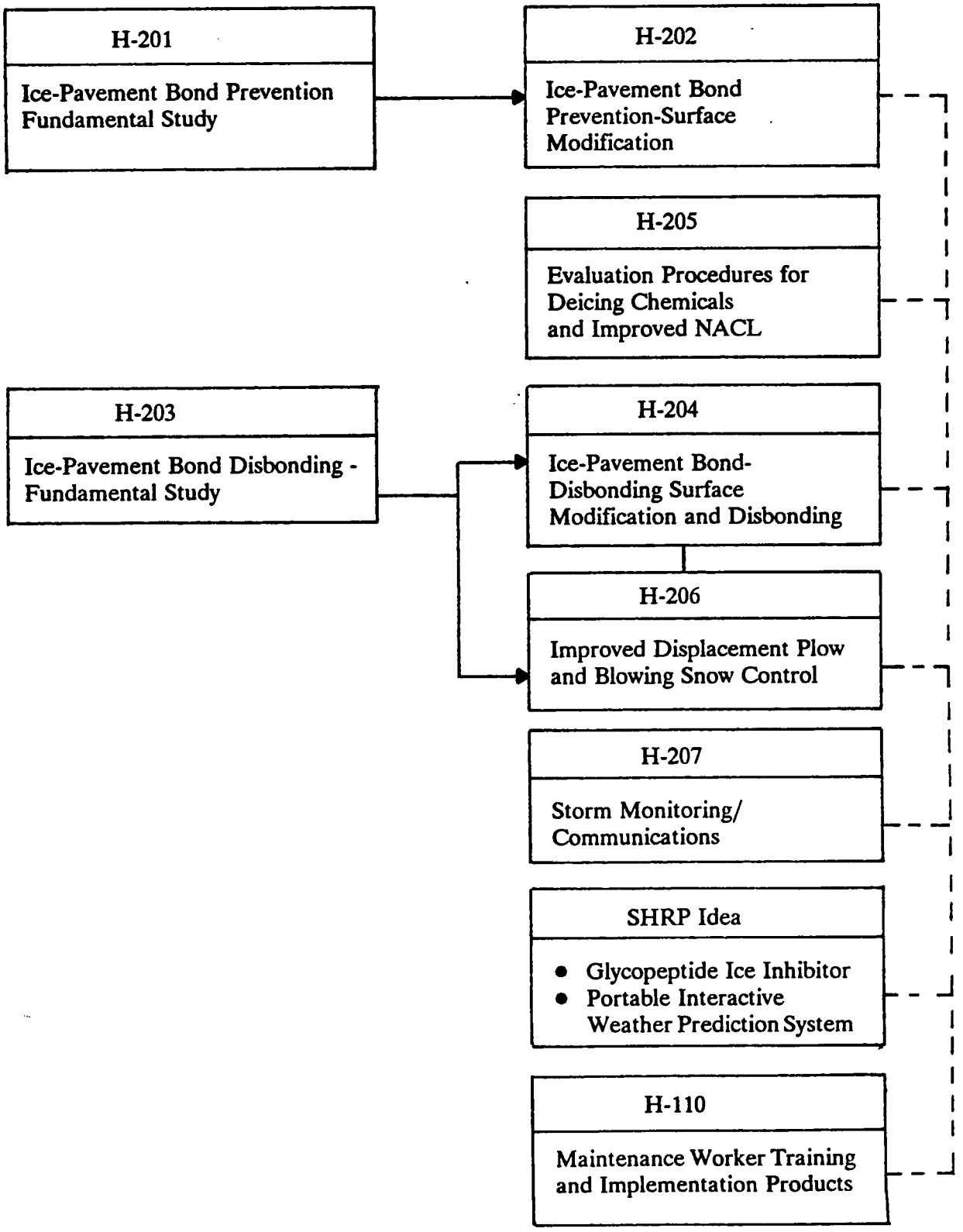


FIGURE 2-3

SHRP HIGHWAY OPERATIONS PROGRAM
EXPECTED RESULTS

CONTRACT NO. TITLE	CONTRACTOR	TIME FRAME	TOPICS BEING INVESTIGATED	RESULTS TO BE ACHIEVED	PRODUCTS TO BE DEVELOPED
1. H-101 - Pavement Maintenance Cost Effectiveness	Texas A&M University	October 1987 - October 1992	Effectiveness of pavement maintenance treatments for asphalt pavements and rigid pavements: - Crack Sealing - Slurry Seal - Chip Seal - Thin Overlay - Joint Sealing - Undersealing PCC.	Development of method for evaluating cost effectiveness of the various maintenance treatments. Better understanding of the basic mechanisms by which specific treatments extend the life of pavement.	1. Handbook of Pavement Maintenance Effectiveness. 2. Training Course on How to Use Pavement Maintenance Effectiveness. 3. Data Collection Manual. 4. Evaluation Guidelines.
2. H-104 - Fabrication and Testing of Maintenance Measuring Equipment	H-104A Geophysical Survey Systems, Inc.	April 1990 - March 1993	Equipment to be used to effectively determine the need for and evaluate the effectiveness of preventive maintenance on a network basis utilizing ground penetrating radar.	Design, construction and testing of prototype equipment to measure specific pavement conditions.	1. Specification and Design of Equipment. 2. First Generation Prototype with documentation. 3. Second Generation Prototype with documentation. 4. Report on results of field tests.
	H-104B University of Texas at El Paso	April 1990 - March 1993	A method to determine the need for and evaluate the effectiveness of preventive maintenance on asphalt and PCC pavement on a project basis utilizing wave propagation technology.	Design, construction and testing of prototype equipment to measure specific pavement conditions.	
3. H-106 - Innovative Materials Development and Testing	Unknown at this time.	September 1990 -	New and modified materials which will improve the effectiveness and efficiency of repairs to potholes, partial depth spalls, crack and joint sealing and filling.	Laboratory and short-term testing of selected materials. Evaluation of material performance. Recommendations for long-term testing. Documentation of preferred usage and application techniques.	1. Evaluation reports on each material: - Laboratory Tests - Short-Term Field Tests. 2. Manual for each repair method: - Performance - Application. 3. Training Packages. 4. Recommendation for Long-Term testing.

Figure 2-3

CONTRACT NO. TITLE	CONTRACTOR	TIME FRAME	TOPICS BEING INVESTIGATED	RESULTS TO BE ACHIEVED	PRODUCTS TO BE DEVELOPED
4. H-107 - Innovative Equipment Development and Testing	Unknown at this time.	September 1990 -	New and modified equipment which will improve the effectiveness and efficiency of repairs to potholes, partial depth spalls, crack and joint sealing and filling.	Develop, fabricate, test and demonstrate prototype equipment which will enhance speed, efficiency, quality and safety of repairs. Prepare documentation on specification and design of equipment..	1. Specification and design of equipment. 2. First generation prototype with documentation. 3. Results of laboratory testing. 4. Second generation prototype with documentation. 5. Report on results of field tests. 6. Recommendation on development of production models.
5. H-109 - Maintenance Work Zone Safety Device Development and Evaluation	ENSCO, Inc.	January 1990 - January 1993	Twenty-five separate devices which will be used in maintenance work zone safety: - Barrier Design - Warning Devices - Rumble Strips - Delineation Device - Lighting Devices - Signs/Flagging Devices.	To fabricate, test and evaluate the 25 devices under laboratory and field conditions. Document final design and specification of successful devices.	1. Appraisal report for continuation of fabrication and testing. 2. Evaluation Plan. 3. Report on results of laboratory and test track testing. 4. Report on open highway testing of commercial devices. 5. Evaluation of prototype device along with plans and specification for commercial manufacturers. 6. Applicability guidelines. 7. Implementation and training package for each device.

Figure 2-3

CONTRACT NO. TITLE	CONTRACTOR	TIME FRAME	TOPICS BEING INVESTIGATED	RESULTS TO BE ACHIEVED	PRODUCTS TO BE DEVELOPED
6. H-205 - Evaluation Procedure for Deicing Chemicals and Improved NACL	Midwest Research Institute	April 1988 - April 1991	1. Physical and chemical effects of deicing materials. 2. Method for improving NACL in order to reduce harmful effect and improve melting properties.	Development of a standard methodology to test and evaluate deicing chemicals. Recommendation for use/application of NACL. Design of modified NACL material which is more effective and environmentally safe.	1. Recommended testing protocol for the complete characterization of chemical deicers. 2. Test methods handbook for structured testing of chemical deicers and evaluating usage. 3. Design of improved NACL deicing material.
7. H-206 - Improved Displacement Plow and Blowing Snow Control	University of Wyoming	October 1988 - March 1993	1. Design of displacement plow. 2. Design and placement of snow fences. 3. Roadway designs which affect drifting snow.	Improved design of displacement plow moldboard, controls and cutting edge. Improved design of snow fences. Criteria for the placement of snow fences which would improve visibility and reduce drifts. Recommended modification of roadway design practice which would contribute to reduction of snow buildup on roadway.	1. Detailed design and specification for manufacture of improved-performance snow fence products. 2. Illustrated guide for selection, placement and use of snow fences. 3. Illustrated guide for selecting and using appropriate snow drift reducing criteria in the design of new or reconstructed highways. 4. Two full-scale prototype displacement plows with documentation. 5. Design and specification for displacement plow. 6. Edited video tape on performance of new plow design.

Figure 2-3

CONTRACT NO. TITLE	CONTRACTOR	TIME FRAME	TOPICS BEING INVESTIGATED	RESULTS TO BE ACHIEVED	PRODUCTS TO BE DEVELOPED
8. H-207 - Storm Monitoring and Communication	Matrix Management Group	October 1988 - October 14, 1991 *New end date January 1992	1. Storm monitoring system effectiveness. 2. Pavement sensor usage and effectiveness. 3. Alternative responses to full range of storm conditions. 4. Improved interagency and intra-agency communications with the public.	Development of an effective storm monitoring system for inter-agency or intra-agency use. Development of criteria for best placement of sensor or integrating them into a functioning system. Criteria for evaluating alternative responses to full range of conditions encountered in snow and ice situations. Procedure for selecting the appropriate mechanical/chemical or other treatment based on the existing and projected conditions.	1. Illustrated manual for inter-agency and intra-agency communication system (RWIS). 2. Illustrated manual for implementing conditions sensing devices. 3. Operations manual on procedures for selecting optimal mechanical, chemical or other snow and ice treatments.
9. SHRP Idea - Glyco-peptide Ice Inhibitor	Virginia Polytechnic Institute, Blacksburg, VA	October 1990 (end date)	1. Use of glycopeptide as ice inhibitor. 2. Manufacture of larger quantities of glycopeptide.	Production of small amounts of glycopeptide. Concept for production of glycopeptide.	1. Milliliter quantity of glycopeptide. 2. Report that identifies options for production of glycopeptide.
10. SHRP Idea -Portable Interactive Intelligent Weather Prediction System	Wells Research Corp., Ft. Collins, CO	November 1990 (end date)	1. Use of laptop computer to predict local weather conditions using C level news model.	System for identifying local weather conditions to be used by highway maintenance personnel.	1. Software model for local weather prediction to be used on laptop computers.
11. H-208 Development of anti-icing technology	To be determined	April 1991 thru March 31, 1993	1. Anti-icing technique using various materials, chemicals, and equipment.	Effective treatment program using anti-icing techniques.	1. Report on effectiveness of anti-icing techniques. 2. Survey of equipment source and evaluation of equipment. 3. Manual of practice for anti-icing treatment

nation's infrastructure. A review of both types of organizations was made in order to develop a characterization of each. This was done in order to identify:

- Functional areas within the organization that may be affected by technological improvements or changes in maintenance activities;
- Specific types of personnel within each functional area who would receive, transmit or make decisions about the technology; and
- Types of information which personnel would need to take some positive action to implement the technology.

State Highway Agencies

A review of the current organizational structure of the 50 state highway agencies was made. Current organization charts of the state highway agencies were obtained, reviewed, and analyzed noting location and function of maintenance and other activities that would affect implementation of maintenance technology. Based on this review the "typical" organizational structure shown in Figure 2-4 was developed. This structure identifies the basic functional areas where maintenance activities are concentrated, as well as other parts of the organization which have an impact on the implementation of any new technology.

Maintenance operations can be characterized as one of two types -- policy and programming activities which are typically the responsibility of head office personnel, and implementation activities which are carried out by district and field personnel. Personnel who typically carry out these activities are identified by title and function as shown in Figure 2-5. Traffic engineering personnel are also identified because of their involvement in work zone safety and in some cases pavement condition analysis.

Within the head office, maintenance operations are usually managed by a department head who sets policy and procedures for maintenance activities on a statewide basis. This function usually does not change from state to state; however, some states have this department head reporting to a manager who controls not only maintenance but also construction, materials testing and investigation activities. The other states do not use this higher tier of management. They have each department reporting to either the Chief Engineer or the State Highway Director.

FIGURE 2-4

TYPICAL HIGHWAY AGENCY ORGANIZATION

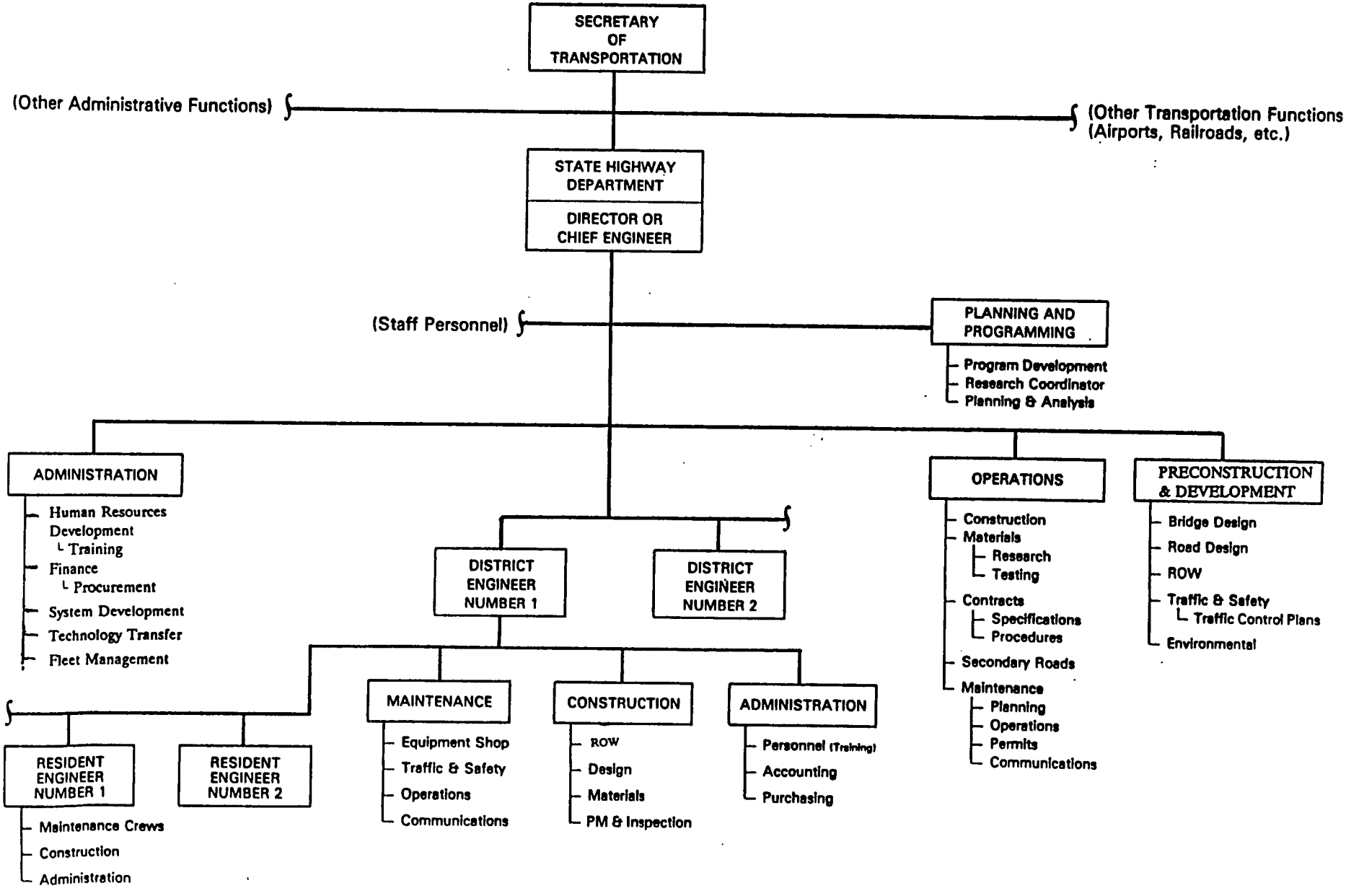


FIGURE 2-5

HIGHWAY AGENCY PERSONNEL WHO ARE DIRECTLY AFFECTED BY SHRP OPERATIONS RESEARCH

MAINTENANCE PERSONNEL

State Maintenance Engineer - One in an executive capacity who supervises all activities of maintenance for the State Highway and Transportation Department.

Assistant State Maintenance Engineer - One who assists the State Maintenance Engineer in the work of supervising the activities of maintenance.

District Engineer - (In some states, called Division Engineer or Regional Engineer) - One in an executive capacity who supervises highway activities within a district.

District Maintenance Engineer - One in an executive capacity who supervises maintenance activities of highways within a district.

Assistant District Maintenance Engineer - One who assists the District Engineer and/or the District Maintenance Engineer in supervising maintenance within a district.

Resident Maintenance Engineer - One who directs the activities of all maintenance employees and equipment and oversees the maintenance of highways within a residency.

Area Supervisor - (In some states, called Superintendent) - One who directs the activities of all maintenance employees and equipment and oversees the maintenance of highways within a residency, excluding engineering requirements.

Gang Foreman - One who directs the activities of a group of employees engaged in maintenance and betterment work such as a grading crew, bituminous repair crew, concrete pavement patching crew, bridge repair crew, roadside maintenance crew, etc.

Sectionman - One who in reality is a working foreman, or who can and does perform any of the work necessary to properly maintain the highways within a specified territory; in addition, supervises the work of operators and laborers when necessary.

Laborer - One who performs manual labor.

Skilled Craftsman - One who through special training or experience has become proficient in a trade such as a carpenter, painter, mason, plumber, etc.

Shop Superintendent - One who is responsible for the operation of a central garage and the supervision of major overhaul and repair of equipment.

Garage or Shop Foreman - One who is responsible for the operation of a garage and the supervision of the maintenance and repair of equipment.

Mechanic - One who under direct supervision, maintains and repairs all types of equipment.

Mechanic Helper - One who assists the mechanic in the maintenance and repair of all equipment.

Equipment Operator I - Operator of light trucks, mowers, patching rollers, etc.

Equipment Operator II - Operator of heavy trucks, light graders, and rollers used on resurfacing projects.

Equipment Operator III - Operator of specialized equipment such as cranes, shovels, heavy graders, paving machines, etc.

Timekeeper or Clerk - One who keeps the time records of employees, hours of equipment usage, quantities of materials received, used, and on hand; maintenance cost records, etc.

TRAFFIC OPERATIONS PERSONNEL

State Traffic Engineer - One in an executive capacity who supervises all activities related to traffic operations of the State Highway and Transportation Department.

Assistant State Traffic Engineer - One who assists the State Traffic Engineer in the work of supervising traffic operations.

State Traffic Maintenance Engineer - One in an administrative capacity who programs and implements all phases of maintenance for traffic control activities under the supervision of the State Maintenance Engineer.

District Traffic Engineer - One in an administrative capacity who programs and implements all phases of maintenance for traffic control activities under the supervision of the State Maintenance Engineer.

Assistant District Traffic Engineer - One who assists the District Traffic Engineer in the work of supervising traffic operations within a district.

Sign Supervisor - One who directs the activities of all signing, both fabrication and erection.

Sign Shop Foreman - One who directs a crew of men in the activity of fabricating traffic signs.

Sign Fabricator - One who specializes in the fabrication of traffic signs.

OTHER RELATED PERSONNEL

Chief Engineer - One in an executive capacity who supervises all engineering activities of a State Highway Department.

Head office operations are typically responsible for the following planning and management activities:

- Formulating of policies and procedures governing maintenance operations;
- Directing the pavement management system and providing guidance for field units in the collection of pavement data;
- Providing advice and practical information on bituminous overlays and other surface treatments;
- Conducting statewide planning and forecasting of maintenance and state-force construction needs, including training and research and analysis directed toward the improvement of the maintenance functions;
- Preparing training materials, conducting of training, evaluating its progress and conducting research directed toward improvement of and maintenance methods;
- Monitoring maintenance performance data and advising field forces in the proper usage and interpretation of maintenance codes and standards;
- Coordinating district sign shop operations; and
- Evaluating new equipment, products and ideas.

In addition to head office maintenance operations, several other functional areas impact the transfer and implementation of new maintenance technology. These are discussed below.

Planning and Programming

This area typically deals with statewide transportation planning and annual construction programming. However, there are several specific functions typically carried out in this division that affect maintenance activities. These are:

- Approval of payment of maintenance funds for primary route extensions and other streets to municipalities (For example: Virginia);
- Conduct of routine and special studies dealing with pavement condition and sufficiency relative to traffic volumes; and

- Reviewing and monitoring of local jurisdictional funding allocations and budgets (For example: West Virginia).

Traffic Engineering

While the traffic engineering function normally focuses on traffic studies, safety analysis, and design for new construction, it is also responsible for design and implementation of work zone safety practices for both construction and maintenance. This activity follows closely the guidelines of the Manual of Uniform Traffic Control Devices (MUTCD). As part of this effort directional devices, barricades and barriers are evaluated and recommended for use. Also, in some states traffic engineering personnel are responsible for or involved in the development and/or conduct of pavement condition ratings.

Materials Testing

The materials testing function is typically responsible for testing, inspecting and administering all materials used in both construction and maintenance. It provides tests and analyses of materials suggested by others (maintenance) and keeps abreast of new developments in materials technology recommending their evaluation and use by the department. Activities relating to SHRP highway operations research include:

- Defining, developing and implementing testing procedures for materials and pavements;
- Recommending pavement design and types of repair; and
- Recommending use of new materials as well as tests and certification procedures.

Environmental

Some states have separate management units for environmental activities while others assign the responsibility to sub-units with planning or design. In either case, the issue of using materials which may be harmful to the environment must be addressed and is becoming more of a concern. This responsibility affects the implementation and use of ice prevention and deicing chemicals on roadways.

Equipment

The equipment function is responsible for purchase, maintenance, disposition, rental and replacement of all equipment utilized by a department. Specific functions include:

- Establishing policies and issuing instructions pertaining to equipment operation,
- Equipment inspection and maintenance programs, and
- Establishing and maintaining training programs on equipment operation and maintenance.

Finance

The finance area has two functions which affect implementation of new technology. As a focal point for preparing consolidated budgets and cost estimates, the finance area conducts studies on the cost effectiveness of programs, systems, and individual items proposed for use by a department. Secondly, after inclusion of items within a budget year, monitoring of actual budget performance may have impact on a decision to continue use for successive years. The approach used in analyzing the cost effectiveness of a product may be dictated by this function.

The other function typically carried out within finance involves procurement or purchasing of items for use by a department. As such they must prepare bid packages and requests for quotes. This includes specifications and other benchmarks that are used to evaluate vendor bids.

Human Resource Development

This area, referred to as "personnel," usually contains some type of training function. The training can be either centralized or highly decentralized. In centralized agencies, this training organization has overall control of the department's training program as well as the training budget. Other functions, such as maintenance, must submit requests for training and wait until it is planned, scheduled and implemented. In decentralized programs, the head office training organization acts only as coordinator and facilitator to other operational units of the department. Under this scheme, maintenance is able to decide its own training program, prepare or procure the training material and implement training using its own resources or that of the district support staff.

District Organizations

For the districts, the majority of states have an organizational and reporting structure that directly connects to the Chief Administrative Officer of the agency. In the majority of cases, the districts are somewhat autonomous units that work independently within their own geographic bounds.

The district organization is typically a reflection of the head office organization with the exception of the finance and design functions. These two areas tend to remain as centralized functions. Other functions and activities as described under the head office are essentially the same with two exceptions:

- Most functional and operating policies are developed and set by the head office organization. The district organization must follow these policies once implemented on a statewide basis; and

- In the maintenance areas, work on state facilities is carried out by personnel assigned to the district or sub-district, not the head office.

In most cases districts have sufficient resources to act independently in carrying out the mission of the department. Small states, or those with very centralized organizations tend to have greater direct influence over the programming of work and the procedures used by the districts.

Local Public Works Organizations

Local public works organizations play an important role in the maintenance and rehabilitation of road systems at the local level. A significant amount of funds are expended annually in maintaining local roads, bridges and drainage systems and in deicing and snow removal in urban areas. According to the ICMA 1989 Municipal Index there are more than 3,000 municipalities within the United States with a population of over 10,000. Most of these municipalities have either a Public Works Director, a City Engineer, a Street Superintendent or a combination of all three. In addition within the municipalities, there are 3,043 counties with jurisdiction over highways, rural roads, bridges and other infrastructure in their area.

Types of personnel who are involved in either the decision-making or implementation processes within local jurisdictions are as follows:

Municipal	County
Director of Public Works	County Administration
Chief Financial Officer	County Manager
City Engineer	County Engineer
Street Superintendent	Planning Director
Equipment Manager	Chief Financial Officer
Planning Director	Purchasing Director
Purchasing Director	

A typical public works organization for a city or municipality might follow the structure shown in Figure 2-6. While the scope of the geographic responsibility of these organizations is much smaller than the state, their organizational structure can be quite large, have as many or more personnel and be a more sophisticated operation overall. Large metropolitan areas such as Los Angeles, Chicago, New York and Boston are examples of cities with large and complex organizations within their Public Works Department. Requirements for new technology are just as critical in these localized areas. Transfer of any new technology resulting from SHRP research should also be focused at these organizations.

Technology Transfer Activities

Technology transfer is defined as the process by which research findings and new technology are transferred into useful processes, products and program. It can serve two functions in a highway agency technology adoption process:

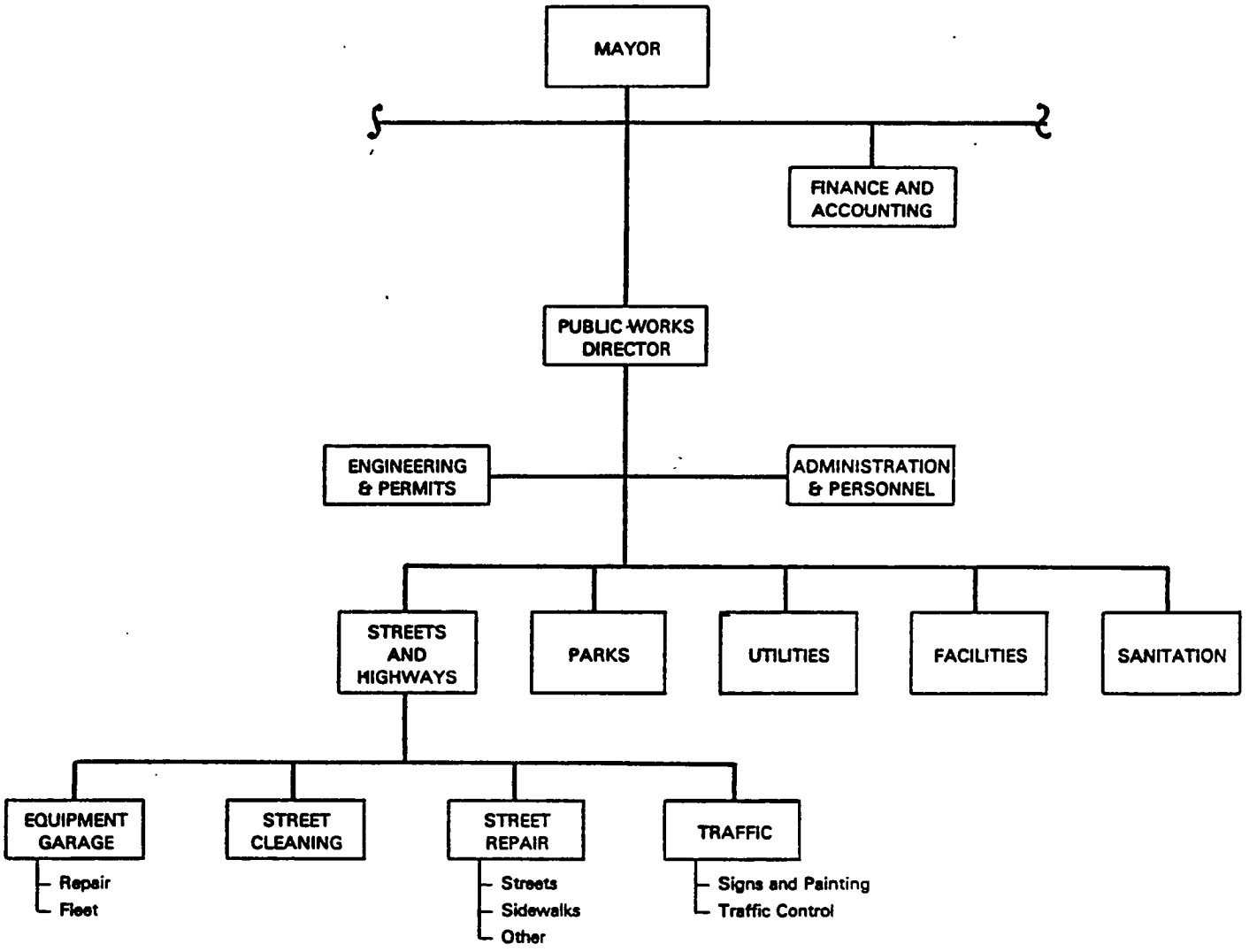
- It allows the agency to act as receiver of new information from outside sources; and
- It allows the agency to act as a provider or promoter of information to various offices within the agency and also to other transportation agencies (for example, county, local or municipal agencies within the state).

This process as a formal highway engineering discipline has been used for about 20 years (1). The basic steps of this process are:

- Identification,
- Planning,
- Packaging,
- Promotion,
- Evaluation, and
- Adoption.

FIGURE 2-6

TYPICAL PUBLIC WORKS ORGANIZATIONS (Municipality)



Because technology innovation has increased rapidly over the last 30 years, states are becoming more aware of the need to manage this phenomenon effectively in order to know about what new concepts, systems or materials are available and adaptable for their use.

Most states follow this process in some manner. However, it was not until recently that states have recognized the need to formalize the process and assign responsibility to some specific organizational unit or individual. Based on information from a survey conducted by the General Accounting Office (GAO), a summary of the technology transfer effort in highway agencies is shown in Figure 2-7. Appendix A lists the technology transfer effort by state highway agency as noted from the survey.

As can be seen, most states have some mechanism to receive information or to promote transfer of a successful technology, either through a technology transfer office or through specified personnel. Of the 21 highway agencies which have technology transfer offices most are located in either the Planning division or the Research and Development unit. Figure 2-8 summarizes this information and identifies other organizational units which house technology transfer offices.

Determination of Information and Training Needs

Information and training needs are addressed here as two separate topics. While the same information in some cases is required for informational and training purposes it is being provided for two different reasons. Therefore it may be more effective to package the material in different ways to meet the specific need in each area.

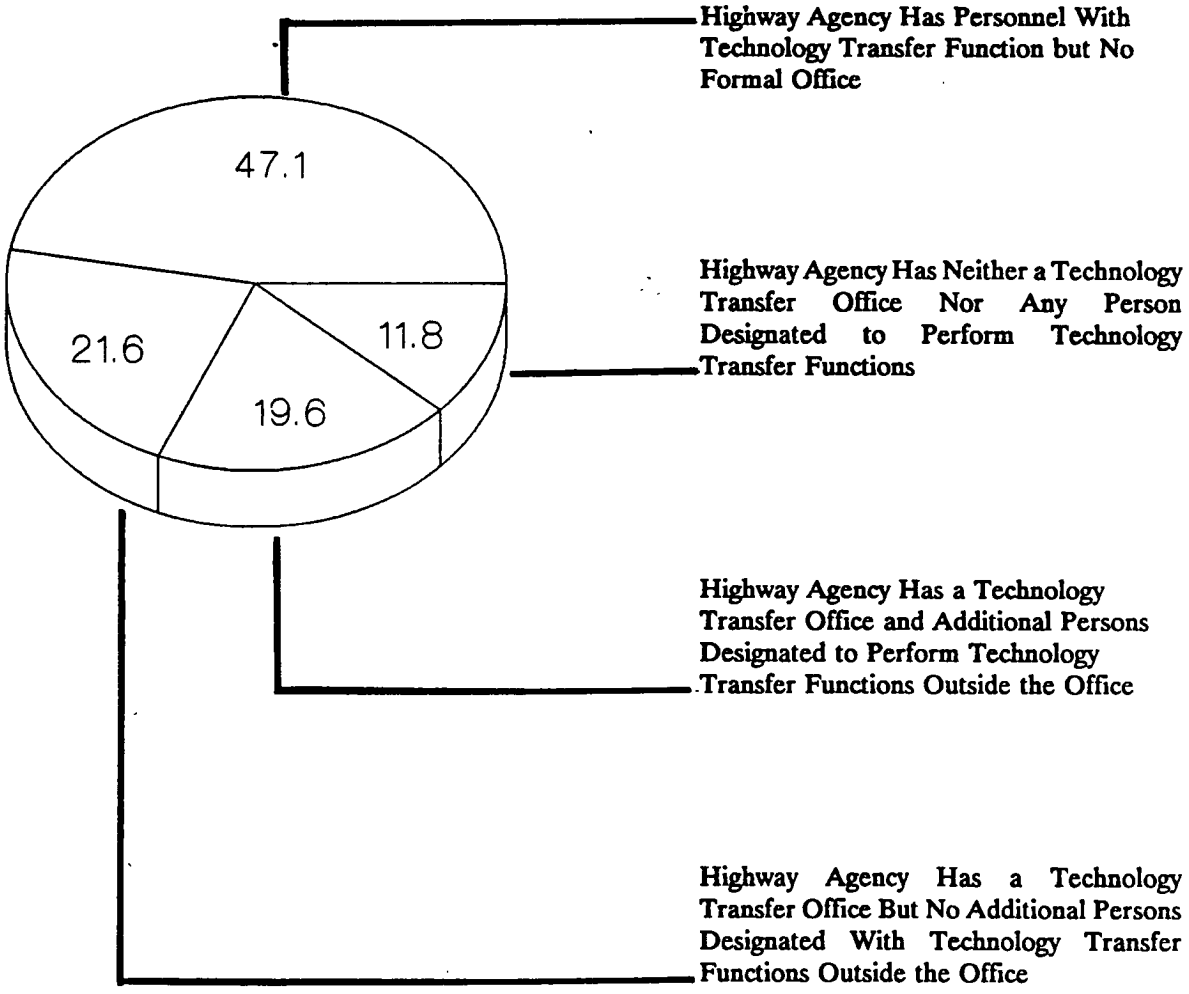
Information Needs

Highway technology adoption is a decision process that involves input from a variety of factors. Included in this process are collection of physical data, projections of future conditions, estimation of economic and other constraints, evaluation of performance, and other decision-making activities and criteria. Highway officials learn about technologies from a wide variety of sources and rely on these sources to differing degrees. This section of the report summarizes three main questions with regard to information gathering:

- Where do states get their information (data)?
- What type of information do they require?
- How do they use the information?

FIGURE 2-7

TECHNOLOGY TRANSFER EFFORTS
FOR THE 51 STATE HIGHWAY AGENCIES[1/]



Percentages do not total 100 percent because of rounding

1/ GAO/PEMD-88-19 State Adoption of New Highway Pavement Technologies

FIGURE 2-8

TECHNOLOGY TRANSFER OFFICE
LOCATION WITHIN STATE HIGHWAY AGENCY[1/]

Division or unit	Number of highway agencies
Research and development	7
Planning	5
University and state highway agency cooperative effort	4
Engineering or operations	2
Other	
Bureau of materials and research	1
State aid unit	1
Administrative	1
TOTAL	21

1/ GAO/PEMD-88-19 State Adoption of New Highway Pavement Technologies

Answering these questions determines the information needs required with respect to transferring a technology from research into actual use.

Where Do States Get Their Information?

State highway officials have many sources from which to draw regarding new technologies. With today's modern communication systems, most information and data sources are only a push of a button away. For example, computer data bases make it possible to have random access to large volumes of published research information using a personal computer and communication link. Printed matter about many topics is available by filling out a coded request card or calling an 800 telephone number.

The GAO study on How State Agencies Adopt New Pavement Technologies (2) looked at how state highway officials learn about and select technologies for testing and evaluation. Results of a portion of a questionnaire which they completed are shown in Figure 2-9. Fifteen main sources of information were identified along with the level of reliance on each source. Responses show that highway officials rely most on FHWA, research and development at state departments of transportation, TRB and NCHRP.

FHWA and AASHTO expend much effort in making information on new technology available to state agencies in order to reduce needless and expensive duplication of testing and evaluation. This is done through many dissemination activities such as publications and seminars as well as local and regional presence of personnel who can communicate information on a personal basis. There are also two special lists which are updated periodically and made available on a wide basis. It would therefore be useful to foster the early involvement of the National Government in disseminating SHRP research results, including meeting and periodically coordinating with Mr. Richard McComb, SHRP Coordinator for the FHWA.

The AASHTO-FHWA Special Product Evaluation List (SPEL) is the most comprehensive tabulation of information available to highway and transportation departments on new product evaluation. The National Experimental Projects Tabulation (NEPT) summarizes data submitted to FHWA by states participating in experimental projects in the FHWA Experimental Construction Program.

Conversely, officials do not rely to a great extent on county or municipal personnel, trade magazines, their own state highway field staff, or trade associations as a source of technological information.

FIGURE 2-9

SOURCES HIGHWAY OFFICIALS
USE TO LEARN ABOUT TECHNOLOGIES[1/]

SOURCE	Number of agencies		
	No, little, or some extent	Moderate extent	Great or very great extent
National			
FHWA	2	8	41
AASHTO	13	20	18
TRB and NCHRP[a/]	3	13	34
TRIS and HRIS[b/]	16	17	18
State			
University research	17	18	16
State agency research and development laboratory[a/]	6	7	29
Reports from other state agencies	9	24	18
New-product evaluation office[a/]	8	10	19
Materials testing lab[a/]	8	18	25
State highway field staff	31	10	10
County or municipal personnel[a/]	46	1	1
Peer exchange	7	19	25
Industry			
Industry representatives	20	24	7
Trade associations	31	18	2
Trade magazines	35	13	3

a/ State responses do not total to 51 highway agencies. Some responses were categorized as not applicable or missing.

b/ The Transportation Research Information System and the Highway Research Information System are bibliographic information retrieval systems that provide information on transportation and highways.

1/ Highways: How States Agencies Adopt New Pavement Technologies, U.S. General Accounting Office, GAO/PEMD-88-19, August 1988.

What Type of Information Do They Require?

In response to the same GAO questionnaire, it was found that the primary influence on decisions to use technologies were performance and cost factors. The cost factor is further broken down between first-cost and life-cycle cost. In addition to these two primary factors, there are physical factors that are also important. These include compatibility with local environmental conditions and compatibility with past operating practices. Other concerns or issues also identified included:

- Unacceptable cost or delay to motorists,
- Likely loss of employee job rights,
- Lack of equipment to implement,
- Expertise unavailable in state,
- Low bid procurement inhibited use,
- Risk of failure is too high,
- Not supported by key decision makers, and
- Experience of other states (peer pressure).

Each state is somewhat unique in its organizational structure, political climate, public priorities and historical perspective. This diversity tends to weaken the ability to achieve adoption of new technologies. Barriers, such as those listed above are realities to some extent in every state.

Betsold's Study of Methods of Effective Transfer and Implementation of Highway Maintenance Technology (3) listed five major factors relating to the characterizations of a technology that directly affect its adoption:

(1) Relative Advantage: How much better is the new method compared to the way things are currently being done? If a major advantage of the new idea over current practices is not perceived by the potential users, the innovation is not likely to be adopted. Small increases usually are not seen as worth the bother or risk of trying a new technique.

(2) Simplicity: The ease with which potential adopters can understand the innovation. If they do not understand it or how it works or what it can do for them, it will not be used.

(3) Trialability: How easy is it to try out the idea? Also, how easy is it to stop using it if it does not work. If an agency must change procedures and make commitments that it cannot easily get out of, it usually is very resistant to change, no matter what the merits of the innovation.

(4) Observability: How clearly can you see the benefits of the innovation and how clearly can you communicate them to others. It is good to be able to easily see if the innovation saves money or time, rather than if the benefits are long term or difficult to explain.

(5) Cost: The up-front cost of a new idea is important in the decision to adopt or not to adopt. If there is an increase in costs (even if the increase results in a long-term savings), it is more difficult to get an idea adopted than if there were an immediate reduction of costs.

Information about a specific product must be translatable into these five basic characterizations.

In addition to the basic information that characterizes the product, other information is required in order to satisfy numerous policy and procedure requirements of various functional areas. For example: purchasing or procurement is interested in the cost, specifications and legal attributes of the product. On the other hand, maintenance is interested in the performance of the product, method of application, limitations and handling precautions. These conflicting interests sometimes result in the provision of more information than is necessary.

The following list identifies the basic information which is typically required by highway agencies before evaluation of a new product is begun:

- Trade name of product;
- Manufacturer and location;
- Manufacturer representation and location;
- Recommended use and limitations;
- Description, composition and laboratory analysis;
- Plans, sketches, photographs, and specifications;
- Patent states;
- Royalty cost;
- Guarantee terms;
- Features and advantages claimed;
- Existing standards, plans and specification set;
- Instructions to use;
- Material and in-place costs;
- Limitations on availability;
- Willingness to provide samples; and
- Current users (experimental or routine).

Other items which may be required include:

- Background of company,
- Date product introduced to market,
- Other contacts within agency,
- Precautions to be used in handling,
- Known health hazards, and
- Agencies that have rejected the product.

The above information, if not provided in some form by the promoter or vendor, is usually required when states begin their new-product evaluation process. If the information is not included in a report, brochure or other mechanism, it must be noted on some sort of evaluation form. The forms provide those responsible for making important initial decisions with orderly and concise information.

How Do They Use the Information?

In every state some form of the new-product evaluation process is carried out. According to a review of this activity made by NCHRP (4) the process is normally carried out in six steps:

(1) Initial Screening: Initial introduction and review of the product by an individual or committee with recommendation for rejection or continued investigation, information must be presented as described earlier, usually on a new product evaluation form.

(2) Preliminary Examination: Typically includes in-depth study of all material available, including test reports, research reports, and results from other agencies. Results are summarized and recommendations are made for detailed evaluation or rejection.

(3) Detailed Evaluation: This step involves in-house laboratory testing and/or field trials to test performance under local conditions. Completion of this step usually leads to acceptance or rejection of the product.

(4) Translation to Media of Practices: If the product is accepted, results must be converted into the "media of practice" which includes standards, specifications, manuals, policy statements and other internal communications affecting the use of the product.

(5) Implementation: A program for implementation must be designed and executed. The following measures were indicated by the NCHRP Synthesis survey. They included demonstrations, policy statements, training materials, documentation feedback, workshops and promotional announcements.

(6) Performance Feedback: Follow-up and evaluation are carried out to provide documentation of benefits, catch early failures and identify any adjustments required to achieve intended objectives.

Typically there are two approaches used by state highway and transportation departments to carry out the initial steps of the evaluation process (1). New product evaluations conducted under what is referred to as the traditional process is usually initiated by the division(s) most interested in the product. This process is an auxiliary activity of existing operational forms. No special organization is required.

Agencies that use an organization, defined procedures or systems for new product evaluation have modified the traditional approach to provide some degree of structuring to improve control, communications and effectiveness. These modifications include the designation of a single office to be used for initial screening, assignment of responsibility to a single division head for overall coordination and processing of the evaluation, and organization of a specific in-house committee to carry out the evaluation process. When the NCHRP survey was taken in 1982 state procedures were categorized as shown in Figure 2-10. Since that time more states have probably opted for a more formal, methodical evaluation process along modified lines.

Training Needs

Training needs are defined as data or information items required for an employee to be able to do his assigned work effectively and efficiently. These needs are typically broken down into three categories: Knowledge, skill and ability (KSA's):

- Knowledge is that basic information which directs the employee in how to go about doing a particular task or activity.

- Skill is the ability with tools or equipment. For example, smooth operation of a motorgrader in cutting a ditch line.

- Ability is defined as an output requirement. Something the employee must be able to accomplish.

FIGURE 2-10

HIGHWAY AND TRANSPORTATION AGENCIES USING EITHER THE TRADITIONAL OR MODIFIED PROCEDURES FOR NEW-PRODUCT EVALUATIONS[1/]

Traditional	Modified	
California	Alabama	South Dakota
Delaware	Arkansas	Tennessee
Idaho	Arizona	Texas
Kansas	Colorado	Utah
Kentucky	Connecticut	Vermont
Minnesota	Florida	West Virginia
Missouri	Georgia	Wisconsin
Montana	Illinois	Manitoba
Nebraska	Indiana	Ontario
Nevada	Iowa	
New Hampshire	Louisiana	
New Mexico	Maine	
North Carolina	Maryland	
North Dakota	Massachusetts	
Ohio	Michigan	
Rhode Island	Mississippi	
South Carolina	New Jersey	
Virginia	New York	
Washington	Oklahoma	
Wyoming	Oregon	
Nova Scotia	Pennsylvania	

1/ New Product Evaluation Procedures, NCHRP Synthesis of Highway Practice 90, Transportation Research Board, National Research Council, Washington, D.C., June 1982

For example, in defining KSA's for a new piece of highway maintenance equipment the list in Figure 2-11 might be appropriate. This type of information will be considered for each product requiring the development of a training program.

Information on employee characteristics will also be considered in order to define the format level and in some cases the content of the training program. Figure 2-12 is an example of the characteristics identified for operators of automatic patching equipment.

At the beginning of the development of each training product, the following process should be undertaken:

Step #1: Review the overall applications of each research product with the research contractor and SHRP staff. From discussions with researchers and experts in each area, lists will be prepared that identify the main points which need to be covered in the training program.

Step #2: Employee characteristics that have a bearing on the design of training programs will also be defined. These include age, education, experience, relative capacity to absorb training, prevailing attitudes toward training, and geographical locations.

Step #3: A search of the training data base will be made to identify any currently available training that addresses topics similar to the research product. If training material already exists, it will be reviewed to determine the appropriateness of its content and format relative to possible modification for SHRP use.

Existing Training Material and Information Dissemination Media

Identification of existing training and informational material available to highway agencies was accomplished in two steps.

A literature search was conducted to identify sources of training materials provided to highway agencies and a survey was made of all 46 State Technology Transfer Centers. Also, a canvassing and review of publication and promotional media was made to identify how new product information is currently disseminated.

FIGURE 2-11

KSA STATEMENT FOR OPERATION
OF AUTOMATIC POTHOLE PATCHER

Knowledge

1. Of functions of components of roadway structure.
2. Of different types of surface failures and their causes.
3. Of department standards and specifications applicable to repair of road surface.
4. Of different types of material used to repair potholes.
5. Of methods involved in repairing potholes.
6. Of work zone safety requirements when using automatic patching machine.
7. Of procedure to operate automatic patching machine.
8. Of daily preventive maintenance procedures for automatic patching machine.
9. Of records and reports required which are applicable to use of the automatic patching machine.

Skill

1. In the loading and unloading of the automatic patching machine.
2. In the operation of the automatic patching machine.

Ability

1. To recognize plan and organize the work when using the automatic patcher.
2. To ensure that materials used with the machine are suitable and applied properly.
3. To operate automatic patching machine in a safe and effective manner.

FIGURE 2-12

EXAMPLE OF OPERATOR CHARACTERISTICS

Age of Operator	Range: 25 - 65	Average: 40 - 45
Education Level	Range: 4 - 16 years	Average: 7 years
Experience Level	Range: 5 - 35+ years	Average: 15 years

Geographic Distribution: Typically decentralized in Districts, Sub-Districts or resident offices throughout the state. Very few operators assigned to Head Office.

General Characteristics:

(1) Prefer individual or small group training.

(2) Cannot be expected to accomplish training on own time or through home study.

(3) Should not be expected to pay costs.

(4) Will be receptive to training if job-related, is conducted by or mandated by immediate supervisor and provided opportunity for advancement as result of taking training.

(5) Hands-on and audio-visual methods get best results with this group.

In a recent survey conducted by NCHRP, state highway agencies were asked to list and rank ten organizations that provided them with informational material. Figure 2-13 lists the organizations and ranking by the 34 states that responded to the survey (1). In addition to these five organizations, training material is also produced and disseminated by T^2 Centers, manufacturers, other federal government agencies and for-profit businesses which were not listed in Figure 2-13.

One mechanism that is pervasive throughout the industry is technical periodicals. Our review of a number of periodicals shows that new products are routinely presented and promoted in these publications either through feature articles or new product promotion sections as well as advertisements. A list of periodicals which could be helpful in promoting the new highway operation products follows:

- Engineering News-Record,
- Civil Engineering Magazine,
- APWA Reporter,
- American City and County,
- Civil Public Works,
- Facilities Manager,
- Fleet Equipment,
- Public Works,
- Public Works Preview,
- Highway and Heavy Construction,
- Better Roads,
- American Highway and Transportation Monthly,
- American Transport Builder,
- Consulting Specifying Engineer,
- Equipment Management, and
- Roads and Bridges.

Our survey of the 46 T^2 Centers involved a request for copies of their catalogs of training material and the latest edition of their newsletter. The training materials provided by these centers can be categorized as follows:

(1) Workshop/Seminar: Training which covers a specific topic provided by an instructor at a specific location. These workshops or seminars are typically provided at different locations and times throughout the state and repeated on an annual basis. Instructional materials and audio-visual materials such as films, video tapes or slides and view-graphs are used and in some cases may be available for others to use.

FIGURE 2-13

TOP 10 ORGANIZATIONS PROVIDING
TECHNOLOGY TRANSFER INFORMATION TO STATES[1/]

	Organization	Number of States
1.	FHWA	33
2.	TRB	30
3.	Other State Highway Agencies	27
4.	NCHRP	18
5.	Trade Associations	15
6.	Professional Associations	15
7.	Universities	13
8.	AASHTO	13
9.	Industry Publications	12
10.	Other (Local Trade Associations, Local Government, Local Professional Organization)	(Not counted)

1/ Technology Transfer In Selected Highway Agencies, NCHRP Synthesis of Highway Practice 150, December 1989.

(2) Video Tapes: Video tapes are available on either a loan or purchase basis. Tapes are designed to be either stand-alone training or used in conjunction with other mediums such as workshops and seminars. Many videos on highway technologies have become available over the past five years. This mechanism is becoming the most popular form of information dissemination because of its acceptance, flexibility, effectiveness, and very low distribution costs.

(3) Programmed Learning Texts: Texts are available for purchase. In some cases texts are copyrighted and must be purchased in the number to be used. In other cases reproducible copy is provided with the user making the number of copies desired.

(4) Handouts: Handouts are usually short written pieces that cover a particular procedure and method or provide a general overview about some topic such as modern timber bridges. They may be used independently or as support for other topics. In some cases handouts are referred to as brochures.

(5) Computer Programs: Some T^2 Centers make computer programs available for use by states and local agencies. However, programs are considered to be a product to be implemented and not a training device or technology transfer mechanism. Tutorials for operating computer programs are not always part of the package.

A review of the FHWA-sponsored publication State and Local Highway Training and Technology Resources provides some insight as to the types of training material available relative to similar topics being researched by SHRP. Figure 2-14 summarizes the number of types of training products by type of technology according to FHWA.

Identification of Effective Delivery Systems

Delivery systems need to provide effective information or training products quickly and for a reasonable price.

All mechanisms, either individually or in combination, can be useful tools in the context of transmitting information; however, they are not equally cost effective. It is necessary to understand the final product or concept well in order to determine the best mechanism for transferring the technology. At the same time consideration must be given to what this effort will cost and whether such expenditure can be justified in terms of time and coverage.

FIGURE 2-14

NUMBER OF TRAINING PRODUCTS AVAILABLE BY RESEARCH TOPICS[1/]

Research Topic \ Training Mechanism	Workshop/Seminar	Video	Programmed Learning	Slide-Tape Presentation	Handouts	Handbook/Manual
Snow and Ice Control	2	6			4	1
Surface Treatments	10	13	2	4	4	4
Materials Application	4		2	1	1	1
Equipment Usage	40			4	2	
Pavement Condition Measurement				1		4
Work Zone Safety	7	9		6		1

1/ State and Local Highway Training and Technology Resources, Federal Highway Administration and American Public Works Association. FHWA-RT-90-006, January 1990.

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(1) Hodgkins, Edmund A., Technology Transfer In Selected Highway Agencies, NCHRP Synthesis of Highway Practice 150, Transportation Research Board, December 1989.

(2) How State Agencies Adopt New Pavement Technologies, United States General Accounting Office, GAO/PEMD-88-19, August 1988.

(3) Betsold, R. J., Methods of Effective Transfer And Implementation of Highway Maintenance Technology, Federal Highway Administration, FHWA/RD-84/501, July 1984.

3

Conclusions and Recommendations

This section of the report presents conclusions and recommendations that the authors have developed after considering information obtained during the review and analysis effort.

Conclusions

- Products developed for the dissemination of any new or modified technology need to be broken down into two groups:

  + Information Products: Those mechanisms that assist the highway agency manager or maintenance engineer to make a quick decision to evaluate or implement new technology.

  + Training Products: Those mechanisms that help the agency manager or maintenance engineer implement the technology once evaluation and acceptance is completed.

- Not any one mechanism will effectively transfer the technology. The use of several methods and media in combination will accelerate the transfer of information. The selection of approaches must consider the amount of time allowed for transfer (adoption and implementation) the scope of coverage considered necessary for the technology to be effective, and the universal acceptability of the media used.

- The best format for the training material is a function of cost to produce, cost to duplicate, geographic dispersion of the audience, coverage of the topic, learning capacity of the audience and general acceptance by audiences.

- Assistance from the state and local public works agencies will be required in order to network information into the marketplace. Also, it would be advisable to foster the early involvement of the National Government, particularly FHWA's SHRP Coordinator (Richard McComb).

Recommendations

It is recommended that a variety of methods and media be used to provide information and training to users of the SHRP highway operations technology. Emphasis should be placed on reaching primary decision makers and implementers in state and provincial highway agencies. It is recommended that communications and training packages be disseminated by concentrating on workshops and presentations including (1) Regional AASHTO meetings, (2) State meetings of District Maintenance Engineers, (3) Technology Transfer Center Regional Meetings, and (4) APWA meetings. The H-110 contractor will develop such packages in such a format that they can be used by other agencies with little or no preparation. The secondary audience would be decision-makers and implementers at the local (city and county) level. Target audiences can be divided into three basic levels:

- Top-level Management,
- Middle and Functional Management, and
- Implementers.

All informational and training products will target one or more of these levels. Top-level management at the state level is defined as those having overall budget and policy authority for the agency. This includes the Secretary of Transportation, the Highway Department Manager and in some cases the Chief Engineer. At the local level, top-level management is identified as the City or County Administrator or City Manager and Director of Public Works. Middle management at the state and provincial agencies would consist of managers which have direct budget and operational authority over maintenance work as well as division managers whose division is responsible for some activity in the technology transfer process (e.g., materials or planning and programming). At the local level these are the Street Superintendents and Engineering Department Heads.

Implementers are defined as those managers and supervisors who have direct line responsibility for carrying out assigned maintenance activities. For state agencies this function usually starts with a Resident Maintenance Engineer, and includes Area

Supervisors, Gang Foreman and Sectionmen. For maintenance equipment products this also includes Shop Superintendents and Equipment Operators.

We have identified the most effective "media" which should be used in combination to develop training packages which will transfer SHRP highway operations technology to user organizations. The primary method (delivery system) would be workshops, conferences, and demonstrations using these (media) materials. Training overview packages (to be used at each workshop or seminar) should include (1) definition of target audiences, (2) qualifications for instructors, (3) materials and equipment listing, (4) directions to users, (5) trainee handouts, and (6) feedback forms. Recommendations for their use are shown in Figure 3-1 at the end of this Section and summarized below.

Technical Briefs: Technical briefs (see sample in Appendix C) should be written for selected new products (materials and equipment) and systems developed. These briefs should be no longer than two pages (front and back). Some briefs may be formatted like a brochure. They are most effective to summarize the properties and uses of a particular product or piece of equipment.

Promotional Videos: Where appropriate, video tapes should be developed to promote the use of new technology. A focus must be given to first convincing managers that change is of benefit to their agency (creating the climate for change), that the cost is reasonable (both to implement and use) and how it will save time, money and staff requirements. The results must be documented in some kind of media. Video is the best media in this regard because it is versatile in production, easy to use, extremely cheap to duplicate and distribute, and enjoys universal acceptance by audiences. As Marshall McCluhan, the famous communications expert once said, "The media is the message." Since video can actually show the benefits and applications of each new technology, it can be a very powerful means of giving users a "demonstration" (including documentation of "proving trials") of the product and selling them on the benefits of its use. Typically, these videos should be brief (15 minutes or less).

News Articles: News articles should include short information pieces that publicize the development and availability of a new product. Articles should be tailored to the intended audience based upon the publication or periodical involved. A sample article is attached as Appendix D.

Operational Handbooks/Guidelines: Operational Handbooks and Guidelines will be required for each piece of equipment developed and for certain system applications (e.g., storm monitoring systems). In some cases the development of the operational or reference manual is the responsibility of the research contractor. Additional documentation in the form of handbooks and guides may be required for reference purposes during day-to-day operations.

Video Training Tapes: Video training tapes (25-30 minutes each) should be produced for selected products being developed by SHRP. Video tapes are most effective when addressing topics of a method or a procedural nature. The methodology used in developing these videos is contained in the H-110 proposal and is summarized in Appendix E. Appendix F is an excerpt from World Highways magazine which shows how cost effective video training can be when compared to traditional training.

The training video tapes will primarily be used as a training aid to support face to face training. Their purpose is to enhance the training and to do so with a better cost/benefit ratio than most, if not all, other medias. However, the tapes should be designed so that they can also be used on stand alone refresher courses which individuals or groups can review as required.

Photographs: Numerous sets of professional-quality photographs should be taken of many materials and equipment products. These photographs can be used for informational purposes, in brochures and exhibits, and for training in workshops, manuals and self-instructional texts.

In addition to the products shown in Figure 3-1 there are several manuals and training packages which are being produced by the research contractors. The material identified here is intended to compliment the research contractors' material.

The number of communications and training products that ultimately will be produced depends upon the final results achieved by the highway operations research contractors, the emphasis placed on each by SHRP, and on the cost of producing the technology transfer material. Figure 3-2 summarizes the products which should be developed under each mechanism. The cost for each product can only be estimated accurately after the specific research is close to completion. Costs will be included in the H-110 annual work plan.

The communications and training materials produced by the H-110 contractor will differ significantly from those produced by other contractors. Materials produced by researchers will primarily document research results. The materials produced by the H-110 contractor will be designed to implement results. There is a significant difference. The H-110 contractor will also spend a significant amount of effort in providing assistance to other contractors in reorganizing, formatting, and improving their materials prior to publication.

It will also be taken into consideration that "champions" of SHRP exist. They include people from FHWA, AASHTO, etc. The H-110 contractor will enlist their support whenever possible in implementing SHRP.

FIGURE 3-1
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Method For Evaluating Cost Effectiveness for Various Maintenance Treatments	H-101 Pavement Maintenance Effectiveness	<u>Communication Materials</u>																									
		Technical Briefs		●				●	●		●		●	●						●	●			●				
		News Articles	●	●		●		●	●		●		●	●							●			●			●
		Promotional Video		●		●			●		●			●							●			●			
		<u>Training Materials</u>																									
		Seminars/Workshops								●				●							●						
		Video Training Tape						●			●		●	●							●			●			●
		Operational Handbooks/ Guidelines								●				●							●						
		Photographs									●		●	●							●			●			

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Methods and/or Procedures for Specific Pavement Maintenance Treatments	II-101 Pavement Maintenance Effectiveness	Communication Materials																									
		Technical Briefs		●				●	●		●			●						●	●			●			
		News Articles																									
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape				●							●	●						●	●						●
		Operational Handbooks/ Guidelines																									
		Photographs																									

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT	COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL								
		PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
		Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
11-10M Fabrication and Testing of Measuring Equipment: Ground Penetrating Radar for Network Measurement	**Communication Materials**																									
	Technical Briefs		●	●				●		●		●	●			●			●	●			●			
	News Articles		●	●				●		●		●	●							●			●			
	Promotional Video		●					●					●			●				●						
	Training Materials																									
	Seminars/Workshops																						●			
	Video Training Tape			●						●		●	●			●				●			●			
	Operational Handbooks/ Guidelines																						●			
	Photographs									●		●	●			●				●			●			

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Wave Propagation Technology for Project Measurement	11-10A Fabrication and Testing of Measuring Equipment	Communication Materials																									
		Technical Briefs		●	●				●		●		●	●			●			●	●			●			
		News Articles		●	●				●		●		●	●							●			●			
		Promotional Video		●					●					●			●				●						
		Training Materials																									
		Seminars/Workshops																						●			
		Video Training Tape			●						●		●	●			●				●			●			
		Operational Handbooks/ Guidelines																						●			
		Photographs									●		●	●			●				●			●			

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT	COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
		PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
		Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Repair Materials for Pavements 11-10b Innovative Materials Development and Testing	Communication Materials																										
	Technical Briefs		●			●		●		●		●	●				●		●	●			●		●	
	News Articles		●					●		●		●	●							●			●			
	Promotional Video		●					●		●			●							●			●			
	Training Materials																										
	Seminars/Workshops																										
	Video Training Tape									●		●	●							●			●			●	
	Operational Handbooks/ Guidelines																										
	Photographs									●		●	●							●			●				

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Methods of Repairing Pavement Surfaces	II-106 Innovative Materials Development and Testing	Communication Materials																									
		Technical Briefs		●					●		●		●	●						●	●			●			
		News Articles																									
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape																									
		Operational Handbooks/ Guidelines																									
		Photographs																									

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Repair Equipment for Pavements	II-107 Innovative Equipment Development and Testing	Communication Materials																									
		Technical Briefs		●			●		●				●	●	●				●	●	●						
		News Articles		●					●				●	●	●				●	●	●						
		Promotional Video		●					●				●	●	●						●						
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape											●	●	●				●		●						
		Operational Handbooks/ Guidelines																									
		Photographs											●	●	●				●		●						

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Safety Devices for Work Zones	11-109 Maintenance Work Zone Safety Devices Development and Evaluation	Communication Materials																									
		Technical Briefs					●		●	●		●	●	●	●		●			●	●				●	●	
		News Articles							●	●			●	●	●		●			●	●				●		
		Promotional Video							●	●			●	●	●		●			●	●				●		
		Training Materials																									
		Seminars/Workshops								●				●							●						
		Video Training Tape												●			●			●	●				●		
		Operational Handbooks/ Guidelines																									
		Photographs										●		●			●			●	●				●		

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT	COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
		PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
		Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Cutting Edge for Snow Plow Blade II-204 Ice/Pavement Bond Debonding Surface Modification and Debonding	**Communication Materials**																									
	Technical Briefs		●			●		●					●	●				●		●					●	
	News Articles																									
	Promotional Video																									
	Training Materials																									
	Seminars/Workshops																									
	Video Training Tape																									
	Operational Handbooks/ Guidelines																									
	Photographs					●		●					●	●				●		●					●	

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL								
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
A Standard Methodology for Testing and Evaluating Deicing Chemicals	11-205 Evaluation Procedures for Deicing Chemicals and Improved NACL	Communication Materials																									
		Technical Briefs		●			●		●		●			●				●			●			●			
		News Articles		●			●		●		●			●				●			●			●			
		Promotional Video		●			●		●		●			●				●			●			●			
		Training Materials																									
		Seminars/Workshops									●			●				●			●			●			
		Video Training Tape									●			●				●			●			●			
		Operational Handbooks/ Guidelines									●			●				●			●			●			
		Photographs																									

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New/Modified NACL Treatment	11-205 Evaluation Procedures for Deicing Chemicals and Improved NACL	Communication Materials																									
		Technical Briefs		●			●		●		●			●				●	●		●			●		●	
		News Articles		●			●		●		●			●				●	●		●			●		●	
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape																									
		Operational Handbooks/ Guidelines																									
		Photographs		●			●		●		●			●				●	●		●			●		●	

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Snow Plow Design	11-206 Improved Displacement Plow and Blowing Snow Control	Communication Materials																									
		Technical Briefs		●			●		●				●	●	●				●	●	●						
		News Articles		●			●		●				●	●	●				●	●	●						
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape											●	●	●				●	●	●						●
		Operational Handbooks/ Guidelines																									
		Photographs											●	●	●				●	●	●						

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																	FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION		
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New/Modified Snow Fence Design	11-206 Improved Duplacement Plow and Blowing Snow Control	Communication Materials																											
		Technical Briefs		●			●		●				●	●				●		●	●					●			
		News Articles		●					●				●	●				●		●	●								
		Promotional Video							●				●	●						●	●								
		Training Materials																											
		Seminars/Workshops											●	●				●		●	●								
		Video Training Tape											●	●				●		●	●								●
		Operational Handbooks/ Guidelines											●	●				●		●	●								
		Photographs					●						●	●				●		●	●						●		

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL															FIELD PERSONNEL								
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Roadway Design Procedures to Reduce Blowing Snow	H-306 Improved Displacement Plow and Blowing Snow Control	Communication Materials																								
		Technical Briefs		●					●				●	●		●		●		●	●		●		●		
		News Articles																									
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape																									
		Operational Handbooks/ Guidelines											●	●		●	●			●	●		●		●		
		Photographs																									

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Recommended System for Storm Monitoring	11-207 Storm Monitoring Communications	**Communication Materials**																									
		Technical Briefs			●			●	●				●	●			●			●	●	●			●		
		News Articles			●			●	●				●	●			●			●	●	●			●		
		Promotional Video			●				●				●	●						●	●	●					
		Training Materials																									
		Seminars/Workshops				●		●					●	●						●	●	●					●
		Video Training Tape				●		●					●	●						●	●	●					●
		Operational Handbooks/ Guidelines						●					●	●						●	●	●					
		Photographs						●					●	●						●	●	●					

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT	COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
		PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
		Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Placement and Testing of Weather Condition Sensing Devices	11-207 Storm Monitoring Communications																										
	Communication Materials																										
	Technical Briefs			●		●	●	●				●	●				●		●	●	●	●			●	
	News Articles																										
	Promotional Video																										
	Training Materials																										
	Seminars/Workshops																										
	Video Training Tape						●					●	●				●		●	●		●					
	Operational Handbooks/ Guidelines						●					●	●				●		●	●		●					
	Photographs			●		●	●					●	●				●		●	●		●			●	

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
Method for Selecting Snow Removal Treatment	81-207 Storm Monitoring Communications	**Communication Materials**																									
		Technical Briefs			●		●	●	●				●	●				●		●	●	●	●			●	
		News Articles																									
		Promotional Video																									
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape																									
		Operational Handbooks/ Guidelines																									
		Photographs																									

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL										
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION		
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
New Application Methods	II-20A Assessing Techniques	Communication Materials																										
		Technical Briefs																										
		News Articles																										
		Promotional Video																										
		Training Materials																										
		Seminars/Workshops																										
		Video Training Tape									●		●	●	●			●		●	●							
		Operational Handbooks/ Guidelines																										
		Photographs																										

FIGURE 3-1 (Continued)
FUNCTIONS/RESEARCH TOPICS/AUDIENCE

RESEARCH PROJECT		COMMUNICATION AND TRAINING MATERIALS	CENTRAL OFFICE PERSONNEL																FIELD PERSONNEL									
			PLANNING/ PROGRAMMING			ADMINISTRATION				OPERATIONS						PRE-CONSTRUCTION DEVELOPMENT			MAINTENANCE				CONSTRUCTION			ADMINI-STRATION	
			Program Development	Research Coordinator	Planning and Analysis	Human Resource Management	Procurement	Systems Development	Technology Transfer	Construction	Materials and Tests	Contracts	Secondary Roads	Maintenance	Equipment Service	Design	Traffic/Safety	Environmental	Equipment Shop	Resident Engineer	Operations	Communications	Design	Materials	Traffic and Safety	Purchasing	Personnel/Training
		Communication Materials																									
		Technical Briefs																									
		News Articles		●									●	●						●	●						
	SIIRP Ideas for Snow and Ice Control	Promotional Video		●									●	●						●	●						
		Training Materials																									
		Seminars/Workshops																									
		Video Training Tape		●									●	●						●	●						
		Operational Handbooks/ Guidelines																									
		Photographs																									

FIGURE 3-2

RECOMMENDED TYPES OF INFORMATIONAL AND TRAINING PRODUCTS TO BE DEVELOPED[1/]

		Information			Training[3/]			
Project Number	DELIVERABLES UNDER EACH SHRP HIGHWAY OPERATIONS RESEARCH PROJECT[2/]	Technical Brief	News Article	Promotional Video	Seminars/Workshop	Video Training Tape	Operational Handbook/ Guideline	Photographs
101	Method for Evaluating Cost Effectiveness for Pavement Treatments	X	X	X	X	X		X
	New Methods and Procedures for Pavement Maintenance Treatments	X			X	X		
104	Ground Penetrating Radar Measuring Equipment	X	X	X	X	X		X
	Wave Propagation Measuring Equipment	X			X	X		
106	New Repair Materials for Pavement	X	X	X	X	X		X
	New Methods of Repairing Pavement Surfaces	X			X			
107	New Repair Equipment for Pavements	X	X	X	X	X		X
109	New Safety Devices for Highway Work Zones	X	X	X	X	X	X	X
204	New Cutting Edge for Snow Plow Blade	X			X			X
205	Standard Methodology for Testing and Evaluating Deicing Chemicals[4/]	X	X	X	X	X	X	
	New/Modified NACL Treatment	X	X		X			X

1/ This is a recommended plan based on initial research. Actual items produced may vary considerably depending upon numerous factors including budgetary limitations.

2/ It is recommended that communications materials and training packages be disseminated by concentrating on workshops and presentations using the delivery materials developed herein.

3/ For each project, comprehensive training overview packages will be developed to be used at each seminar and workshop. These overview packages will include, but not be limited to: (a) definition of target audience, (b) qualifications for instructors,, (c) materials and equipment listing, (d) directions for users, (e) trainee handouts, and (f) feedback forms.

4/ Contractor to conduct workshop on this topic.

Project Number	DELIVERABLES UNDER EACH SHRP HIGHWAY OPERATIONS RESEARCH PROJECT[2/]	Information			Training[3/]			
		Technical Brief	News Article	Promotional Video	Seminars/Workshop	Video Training Tape	Operational Handbook/ Guideline	Photographs
206	New Snow Plow Design	X	X		X	X		X
	New/Modified Snow Fence Design[4/]	X	X	X	X	X	X	X
	Roadway Design Procedures to Reduce Blowing Snow	X			X			
207	System for Storm Monitoring[4/]	X	X	X	X	X	X	X
	Placement of Weather Condition Sensing Devices	X			X	X	X	X
	Selecting Effective Snow Removal Treatment				X			
208	New Anti-Icing Application Methods			X	X	X		
	SHRP Ideas for Snow and Ice Control		X	X	X			

Appendices

APPENDIX A

STATE HIGHWAY AGENCY TECHNOLOGY TRANSFER EFFORTS[1/]

STATE	No technology transfer office		Technology transfer office	
	No staff with technology transfer functions	Staff with technology transfer functions	No other staff with technology transfer functions	Other staff with technology transfer functions
Alabama		X		
Alaska			X	
Arizona		X		
Arkansas		X		
California				X
Colorado				X
Connecticut				X
Delaware			X	
District of Columbia		X		
Florida		X		
Georgia		X		
Hawaii				X
Idaho	X			
Illinois		X		
Indiana				X
Iowa	X			
Kansas				X
Kentucky		X		
Louisiana			X	
Maine		X		
Maryland		X		
Massachusetts			X	
Michigan			X	

1/ GAO/PEMD-88-19 State Adoption of New Highway Pavement Technologies

STATE	No technology transfer office		Technology transfer office	
	No staff with technology transfer functions	Staff with technology transfer functions	No other staff with technology transfer functions	Other staff with technology transfer functions
Minnesota		X		
Mississippi		X		
Missouri		X		
Montana		X		
Nebraska		X		
Nevada			X	
New Hampshire	X			
New Jersey		X		
New Mexico			X	
New York		X		
North Carolina		X		
North Dakota			X	
Ohio		X		
Oklahoma		X		
Oregon	X			
Pennsylvania		X		
Rhode Island		X		
South Carolina		X		
South Dakota				X
Tennessee			X	
Texas				X
Utah			X	
Vermont	X			
Virginia				X
Washington				X
West Virginia	X			
Wisconsin				X
Wyoming		X		
TOTAL	6	24	10	11

APPENDIX B

Professional Organizations Serving State and Local Organizations (In the Highway Area)[1/]

ORGANIZATION \ SERVICE PROVIDED	Advisory Information Service	Annual Conference	On-Site Tech Assistance		Newsletters	Special Series Reports	Training	Research Projects
Academy of State and Local Governments	✓				✓			✓
American Public Works Association	✓	✓			✓	✓	✓	✓
American Society for Public Administration	✓	✓	✓	✓	✓	✓	✓	✓
Associated Public Safety Communication Officers	✓	✓		✓	✓	✓	✓	✓
Canadian Association of Municipal Administration	✓	✓		✓	✓		✓	✓
Council of Governments	✓	✓	✓	✓	✓	✓	✓	✓
Federation of Canadian Municipalities	✓				✓	✓		✓
Institute of Transportation Engineers	✓	✓	✓	✓		✓		✓
International City Management Association	✓	✓			✓	✓	✓	✓
National Association of Counties	✓	✓	✓		✓	✓		✓
National Association of Towns and Townships	✓		✓	✓	✓		✓	✓
National Governors Association	✓		✓		✓	✓	✓	
National League of Cities	✓		✓		✓	✓	✓	
National Park and Recreation Association	✓	✓		✓	✓	✓	✓	✓
Public Technology, Inc.	✓		✓		✓	✓	✓	✓
The Urban Institute	✓	✓	✓		✓			✓
Water Pollution Control Federation	✓	✓		✓	✓			

1/ The Municipal Year Book, International City Management Association, 1988.

PERIODICALS

Civil Engineering	-	American Society of Civil Engineers
ASCE Journals	-	American Society of Civil Engineers
TRB - Reports, Synthesis, Newsletter	-	Transportation Research Board
AASHTO Quarterly	-	AASHTO
APWA Reporter	-	APWA
Better Roads	-	Dannhavsen Publishing
Transportation USA	-	U.S. Department of Transportation
Canadian Construction Record	-	
Highway and Heavy Construction	-	Cahners Publishing Company
Highway Builder	-	Penn Contractor Association
Surface Transportation R&D in Canada	-	Road & Transport Association
City and Suburban Travel	-	Transit Research Foundation
Engineering News-Record	-	McGraw-Hill Publication
American City and County	-	Communications Channel, Inc.
I&T Journal	-	Institute of Transportation Engineers
Roads and Bridges	-	Scranton Gillette Communications, Inc.
Equipment Management	-	Irving Cloud - Publishing Co.

ASSOCIATIONS

Asphalt

Asphalt Emulsion Manufacturer Association

Asphalt Institute

Asphalt Recycling and Reclaiming Association

Asphalt Rubber Production Group

Associated Asphalt Paving Technologies

National Asphalt Pavement Association

Chemicals

Chemical Manufacturer Association

Concrete

American Concrete Institute

American Society for Concrete Construction

Portland Concrete Association

Construction

America Road and Transportation Builders Association

Associate General Contractor

International Slurry Seal Association

National Society for Computer Application in Engineering, Planning and Architecture

Associate of Bituminous Contractor

Consultants

American Consulting Engineering Council

County

National Association of County Engineers

Engineering

American Public Works Association

American Society of Civil Engineers

National Society of Professional Engineers

American Society for Testing Materials

Safety

National Safety Council

Highway Users Federation for Safety and Mobility

Transportation

Transportation Research Board

Institute of Transportation Engineers

American Association of State and Transportation Officers

Western Association of State Highway Officials

Southern Association of State Highway Officials

TECHNOLOGY TRANSFER CENTERS

Alabama - Fred O'Brien, Jr., Director
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Engineering Research Center
Arizona State University, Tempe, AZ 85287-6306
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(602) 965-1391 (R3T-ASU Electronic Bulletin Board)

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APPENDIX C

TECHNICAL BRIEF

-SNOW FENCE GUIDELINES-

During the past 20 years gradual improvements to snow fence design have been made. Recently, the Strategic Highway Research Program has provided funding for research on blowing snow and drift control and to develop improved guidelines for planing and implementing snow fence systems.

This technical brief describes design concepts as they are currently known for collector type snow fences and summarizes the improved guidelines for snow fence design and placement.

BACKGROUND

Research conducted over the past decade has shown that the cost of using snow fences to alleviate drifting is significantly less than using mechanical means to remove it. This comparison has been made using actual construction costs for fences and average costs for mechanical snow removal. (1) The actual unit cost comparisons are as follows:

- Mechanical snow removal $3.00/ton, and
- Storing snow with fences $0.03/ton.

Results of ten year study of an I-80 snow fence system revealed that accidents in blowing snow conditions were reduced in proportion to the extent of snow fence protection. "Fencing one-half of a 62 mile (100KM) Section of I-80 was found to prevent 54 accidents and 35 injuries over a winter having average snow fall and traffic volume." This results in a cost savings which pays for the fence in less than 15 years (2).

Results of snow fence effectiveness can be seen in the following photographs. Figures 1a and 1b show the difference in visibility between a roadway area protected by a 12.4 foot snow fence and one that is not.

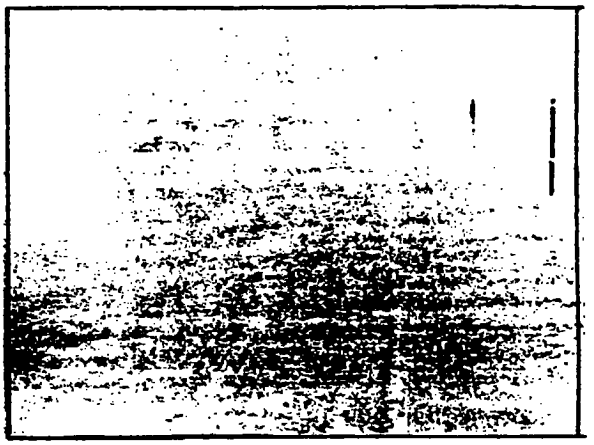

Figure 1a.

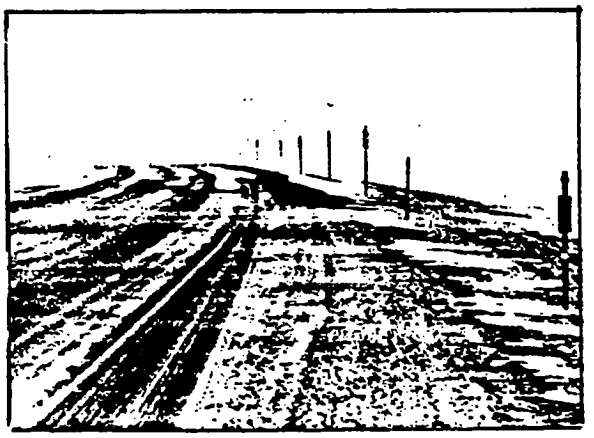

Figure 1b. Improved visibility downwind of a 12.4 fence during moderate drifting.

The top photo was taken 200 feet outside of the protected area, and the photo in 1b was taken a few minutes later standing at the boundary of the protected area.

Results of the research show that reduced wind speeds on the roadway result in general improvement in road-surface conditions

downwind of the fence (Figure 2). This reduction in wind speed and snow transport across the road reduces heat loss and slush accumulation during periods of sunshine with air temperatures above -5°C.

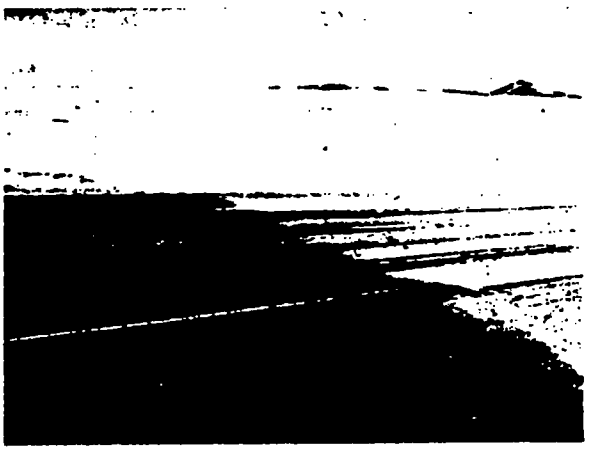

Figure 2. Transition covered by 12 ft. fence located 500 ft. upwind from road.

In order to develop guidelines for design and placement of snow fences two research efforts were undertaken:

- Development of quantitative information on the shape of snow drifts formed by snow fence; and
- Quantification of the vertical distribution of wind-transported snow as a function of wind speed.

Initial research focused on the processes shaping equilibrium snow drifts, with the objective of relating drift shape to barrier geometry.

Turbulent mixing theory was applied using field measurements of wind profile to test hypotheses and to determine values for mixing coefficients. This approach successfully explained the resulting shapes of snow drifts, however useful quantitative relationships have not yet been derived. Until further research can provide reliable formula empirical relationships for drift geometry and snow storage capacity are provided using an extensive database of snow drift profiles.

The determination of the vertical distribution of wind-transported snow as a function of wind speed allows the directional distribution of snow transport and the snow storage capacity to be determined from historical wind records. The vertical distribution of blowing snow also determines the trapping efficiency of snow fences and therefore requirements for fence height and storage capacity.

SNOW TRANSPORT RATE AND VERTICAL DISTRIBUTION

Determination of snow transport rates and the vertical distribution of blowing snow particles is basic to the understanding of snow fence technology.

The wind speed at which snow particles start to move depends on the condition of the snow cover and the density of the air. However, movement of particles usually begins when wind speeds reach 13 mph. The rate of snow transport is very sensitive to wind speed as shown in Figure 3.

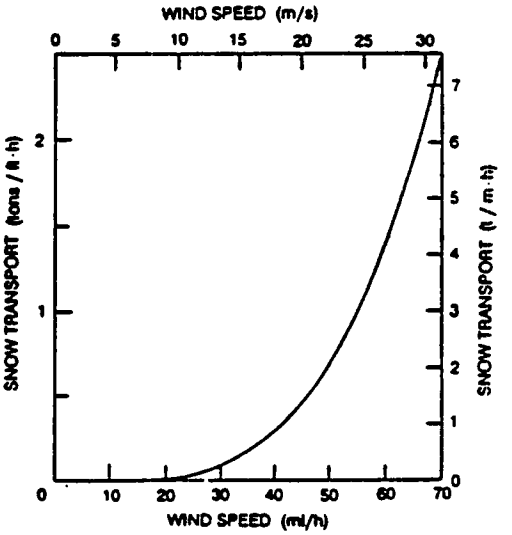

Figure 3. Snow Transport as a function of wind speed (16 ft. layer).

Doubling the wind speed results in a 16 fold increase in snow transport. In very

simplified terms this shows why snow fences are so efficient. Theoretically, reducing wind speed by 50 percent would reduce the snow transport rate by 94 percent. However, the aerodynamic effects of fences also effect the snow transport and therefore reduce this efficiency.

Most snow transport takes place relatively close to the surface. For the purpose of drift control, snow transport above 16 feet can be ignored. The vertical distribution of blowing snow in this 16 foot layer is an important factor in deciding how tall a fence should be. Table 1 shows this vertical distribution of snow transport as a function of wind speed.

Height		Wind speed, mi/h (m/s)				
		22 (10)	34 (15)	45 (20)	56 (25)	67 (30)
-ft-	(m)	%				
0.0- 1.6	(0.0-0.5)	88.5	68.7	51.9	41.1	33.8
1.6- 3.3	(0.5-1.0)	2.4	8.1	12.6	15.2	16.7
3.3- 4.9	(1.0-1.5)	1.6	5.0	8.0	9.9	11.1
4.9- 6.6	(1.5-2.0)	1.3	3.9	6.1	7.5	8.5
6.6- 8.2	(2.0-2.5)	1.2	3.1	4.8	6.0	6.9
8.2- 9.8	(2.5-3.0)	1.1	2.7	4.2	5.2	5.8
9.8-11.5	(3.0-3.5)	1.0	2.5	3.6	4.4	5.1
11.5-13.1	(3.5-4.0)	1.0	2.1	3.2	4.0	4.5
13.1-14.8	(4.0-4.5)	1.0	2.0	2.9	3.5	4.0
14.8-16.4	(4.5-5.0)	0.9	1.9	2.7	3.2	3.6

Table 1.

At low wind speeds (<22mph) less than 10 percent of the snow is transported at heights above 5 feet. As wind speeds increase, the volume of snow transported above the 5 foot boundary greatly increases. At a wind speed of 67 mph, for example, about 38 percent of the snow is transported above 5 feet. This leads to the generalization that effectiveness of a snow fence increase with its height.

HOW A SNOW FENCE WORKS

A snow fence works because a properly designed fence exerts a restraining force on the wind, reducing wind speeds and altering their vertical distribution. This effect reduces the surface shear stress allowing snow particles to settle out in close proximity, both upwind and downwind, of the fence.

Once deposited, the particles tend to freeze together making the deposited snow more resistant to subsequent erosion. The deposited snow accumulates according to the pattern shown in Figure 4.

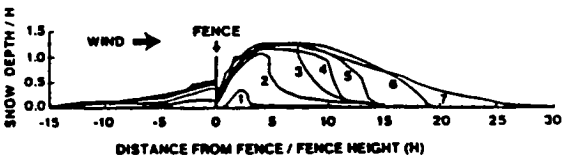

Figure 4. Profile of typical snow drift found by horizontal 50% pores fence.

A drift continues to grow until the shear stress over the surface of the drift becomes uniform. At this point the fence is filled to capacity and the drift is said to be at "equilibrium" and has no further effect on blowing snow. Typical characterization of an equilibrium drift from a fence with 50 percent porosity and a satisfactory bottom gap is as follows:

- length of drift in front of fence - 15H,
- length of drift behind fence - 35H, and
- maximum height of drift (behind fence) - 12H.

In this case the upwind drift contains about 15 percent as much snow as the downwind drift and grows in proportion to the downwind drift.

DESIGN GUIDELINES

The primary factors that must be considered when designing a snow fence are:

- Capacity requirement,
- Fence height,
- Porosity, and
- Placement.

Capacity. Adequate capacity is the most important requirement of any snow fence system. Using the method developed by Tabler (3) that relates snow transport to fetch distance and relocated precipitation the capacity can be calculated using the equation:

$$Q = CPT(1\text{-}0.14^{F/T})$$

where Q is the snow transport per unit of width across the wind, C is a coefficient of proportionality (31.2 for CGS), P is the amount of relocated precipitation, T is the distance the average snow particle travels before complete evaporation, and F is the fetch or length of an area serving as a source of blowing snow.

Solutions to this equation for various values of P, and assuming T = 10,000 ft are shown in Figure 5.

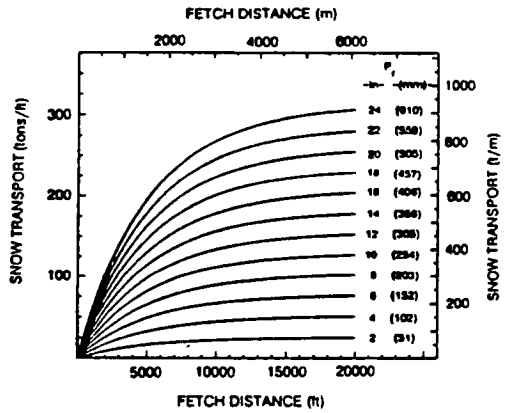

Figure 5. Snow Transport as a function of fetch distance and relocated precipitation.

Height. Once the capacity has been determined the height of fence or number of rows of fence of a specified height required to store the design transport can be calculated from the equation

$$H = 0.064(KQ)^{0.455}$$

where H is the height of the fence in feet, Q is the average annual snow transport, and K is a design modules used with a selected design year.

Required fence heights can be determined using the graph in Figure 6 which is based on the equation. Notice that values are calculated for the upwind and downwind drifts and the combined capacity of both drifts.

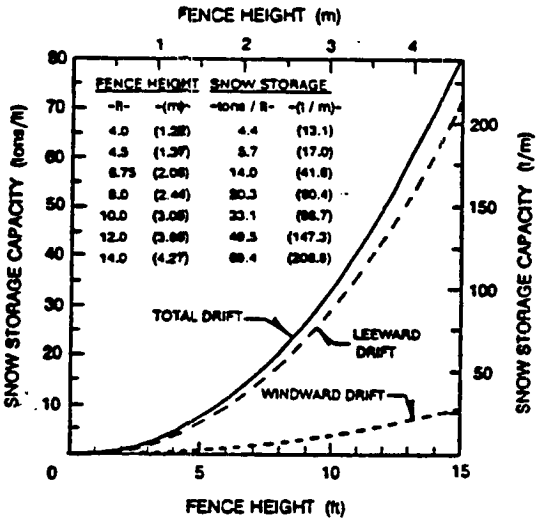

Figure 6. Snow Storage Capacity vs. fence height.

The optimum height for any application depends on required storage capacity, drift control objective, wind speeds and available space. However, one basic relationship remains constant;

Effectiveness increases with fence height.

Cost is also an important factor when deciding fence height requirements. It costs less to build a single taller fence than to build multiple rows of shorter fences having the same storage capacity.

It was found that, over the range of heights investigated, the cost of building a fence is approximately proportioned to fence height, while storage capacity increases with fence height at the rate of the height raised to

the 2.2 power. This relationship is shown in Figure 7 based on data collected from past construction projects.

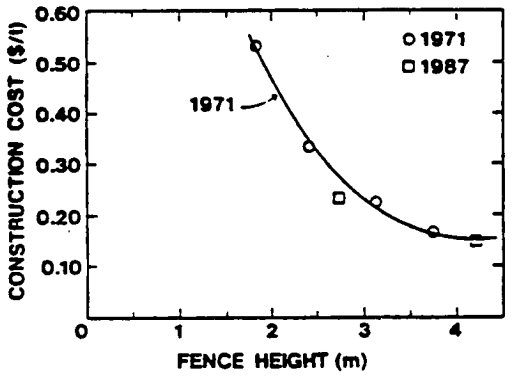

Figure 7. Fence construction cost per unit of snow storage.

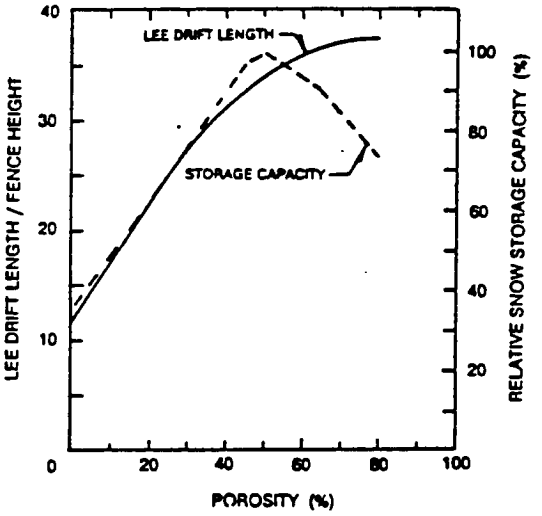

Figure 8. Snow storage capacity and length of leeward drift relative to fence porosity.

Porosity and Bottom Gap. Two other factors contributing to the efficiency of a fence are porosity and bottom gap. In comparison to fence height these two factors have only a minor effect on trapping efficiency, storage capacity and cost, but their effective use in the design can provide additional capacity at no additional cost.

The research has shown that fences having a porosity of 40-50 percent form the largest drifts. Solid fences form larger drifts on their downwind sides, but much smaller drifts on the upwind side and therefore have significantly overall lower storage capacities. Storage capacity and length of the upwind drift vary with porosity as shown in Figure 8.

Fences that become partially or totally buried are not as effective in trapping snow. A gap, or opening, between the ground and the bottom of the fence will reduce the tendency for snow deposition close to the fence and keep the fence from becoming buried.

The effect of a bottom gap varies with the wind speed. In areas where strong winds are common a bottom gap equal to 10-12 percent of the total vertical fence height is optimum on level ground. In other areas of less wind, a gap of 10 percent may be sufficient. Recommended minimum bottom gaps are given in Table 2.

Fencing height		Bottom gap		Total fence height	
-ft-	(-m-)	-in-	(-cm-)	-ft-	(-m-)
4.0	(1.37)	6	(15)	4.5	(1.37)
5.3	(1.62)	8	(20)	6.0	(1.83)
6.0	(1.83)	9	(23)	6.7	(2.04)
7.1	(2.16)	11	(27)	8.0	(2.44)
8.0	(2.44)	12	(30)	9.0	(2.74)
8.9	(2.71)	13	(33)	10.0	(3.05)
10.0	(3.05)	15	(38)	11.2	(3.41)
10.7	(3.26)	16	(40)	12.0	(3.66)
12.0	(3.66)	18	(46)	13.5	(4.11)
12.5	(3.81)	18	(46)	14.0	(4.27)
14.0	(4.27)	21	(53)	15.7	(4.78)

Table 2. Recommended bottom gaps for common height of snow fences.

Placement. Proper placement of a snow fence or fence system is critical to meeting the basic objective of keeping the snow off the roadway. The basic parameters which must be considered are: height of fence (or

fences), wind direction, length of fence, and topography. The following guidelines apply.

1. A fence should be spaced 35H from the area to be protected (in level terrain).

2. Fences should not be placed more than 70H from the area to be protected. This maximum distance depends on the quantity of snow transport, and the topography.

3. Topography, both upwind and downwind of a fence, influences drift shape. On long uniform slopes of 15 percent or less, the drift shape is the same as on level ground. On steeper slopes (>15%) drifts on upward slopes will have shorter and shallower drifts where downward slopes will cause higher deposition on the upwind side of the fence resulting in burial.

4. If multiple rows of fences are required, they should be spaced 25-30H apart. When oblique winds require staggered rows of fence they should be overlapped 20H.

5. Align fences parallel to the road for winds within 25° of perpendicular to the road. Otherwise, orient fence perpendicular to the wind.

6. A fence should extend a enough on either side of the protected area to intercept winds from 30° off the prevailing wind direction.

7. Avoid any openings in the fence if at all possible. When openings are required there should be an overlap of approximately 12H to account for end effect.

More detailed information on the design and use of the snow fence can be obtained from publications such as the "SHRP Pocket Guide to Snow Fences" and the videotape "Successful Snow Fences." Contact the SHRP program for details.

REFERENCE

(1) Tabler, R.D., "Pocket Guide to Snow Fence," Strategic Highway Research Program, 1991.

(2) Tabler, R.D., and Furnish, R.P., "Benefits and Costs of Snow Fences on Wyoming Interstate 80," Transportation Research Record 860 13-20, 1982.

(3) Tabler, R.D., "Snow Fence Handbook," Tabler and Associates, 1988.

APPENDIX D

SAMPLE NEWS ARTICLE

SHRP PROMOTES HIGHWAY OPERATIONS RESEARCH PRODUCTS

by
Steven K. Griffith

NOTE: One photograph will be provided to be used at top of article. Photo will be of video taping activity.

During the early development of the Strategic Highway Research Program highway officials and industry executives were concerned that research efforts funded by SHRP would not find ready acceptance or broad adoption by the highway community. This concern was based on examples of past programs which, when initiated, were well funded and produced significant research results, yet took years for acceptance into common practice.

In order for SHPR research results to be put into practice quickly and effectively, SHRP Program Managers have adopted a pro-active strategy to get the word out about research results. At the SHRP Midcourse Assessment Meeting held in Denver this past August, a session on "Putting SHRP's Products Into Use " was held in the Highway Operations area. There was much discussion about how state agencies and manufacturers view adaptation of new technologies and the barriers that must be overcome.

Although SHRP is only halfway through its five year program, efforts have already been started to overcome the barriers and seek acceptance and adoption of research results. Within the Highway Operations area a number of activities are beginning to take shape.

Results of recently completed research are beginning to be reported in trade publications like (Better Roads),technical journals and at technical conferences such as the TRB Annual meeting.

A communications and training consultant has been awarded a contract to begin developing informational and promotional videos and to work with each of the research contractors to develop reference and training materials which will be needed to implement new or improved products and systems.

Two video tapes that describe the tremendous efforts being put forth by researchers in the highway operations area have already been completed. One tape is a brief ten minute summary of the overall program. It presents the objectives of SHRP and highlights the topics being researched. Its target audience is Chief Administrative Officers and other top executives of transportation agencies. The second video targets operations managers and supervising engineers who are interested in what specific developments from SHRP might do for them. Initial drafts of these

videos were previewed at the Midcourse meeting mentioned earlier. The completed versions have now been sent to over 1000 people throughout North America and Europe who are part of the transportation community.

More videos are in the works. SHRP will now begin to develop material about research which is currently being completed. Topics that are being addressed include:

- Control of blowing snow through snow fence design and placement;
- New and improved work zone safety devices and warning systems;
- Storm warning and monitoring systems; and
- Standard evaluation criteria for deicing chemicals.

The strategy is to develop both informational and training videos as part of the overall technology transfer effort. The informational (or promotional) videos will generate interest among agency managers who are always on the look out for a better mouse trap. This should lead to some investigation by these managers, through small scale deployment or demonstration.
When the time comes for implementation, the training videos, together with other references will provide the basic training materials needed to train personnel.

Videos are not the only medium being employed. SHRP plans to prepare many different types of both promotional and reference materials. News articles such as this provide broad coverage about current status of research and demonstrations. Other efforts include:

- Development and distribution of technical briefs and pocket guides that can be disseminated quickly and easily understood;
- Exhibits and demonstrations at many of the highway and transportation related meetings, conventions, and expositions; and
- Both short and long term demonstrations by as many highway agencies as can be persuaded to participate.

In addition to these efforts SHRP hopes to convince a number of professional organizations to assist in promoting research results through the sponsorship of specialty conferences. Presently two such happenings are becoming reality. The American Society of

Civil Engineers (ASCE) is putting on a conference April 8-10, 1991 in Denver where tangible products of SHRP's research will be highlighted. Conference attenders will have a chance to see equipment demonstrations, attend technical presentations and discuss technical problems with researchers at poster sessions. Another program with an international focus
will be held in Gothenberg, Sweden September 8-11, 1991. This gathering sponsored by the Transportation Research Board and the Swedish Road and Traffic Research Institute will also present research results that can be adapted to activities in other countries.

By taking an aggressive approach to "marketing" SHRP research results it is hoped that very little time and therefore money will be wasted in implementing the results of this significant program.

For more information about the video tapes and other SHRP activities mentioned write in the appropriate reader service number in this issue or contact SHRP Highway Operations Program

Strategic Highway Research Program NNNN

APPENDIX E
VIDEOTAPE PRODUCTION METHOD

Work Plan

Task 1 will involve the following steps:

Step 1.1 -- Develop presentation designs;
Step 1.2 -- Review presentation designs;
Step 1.3 -- Develop draft videotape scripts;
Step 1.4 -- Review draft scripts;
Step 1.5 -- Produce videotape presentations;
Step 1.6 -- Review videotape presentations; and
Step 1.7 -- Finalize videotape presentations for delivery.

Each of these steps is described in the following paragraphs.

Step 1.1 Develop Presentation Designs

The subjects to be covered in the video presentations will first be researched and analyzed to determine what will be included in each presentation. Since these videos must broadly address the needs of all users, this research and analysis must result in the establishment of clear and detailed objectives. From these objectives, a detailed design will be developed for each presentation. Each videotape design will consist of three primary parts:

1. Content outlines -- to identify and organize the detailed content of the video based on initial research findings about audiences and their information needs;

2. Summary of video treatment -- to describe in written form, the types of video approaches that will be used in presenting the video; and

3. Preliminary estimates of production requirements -- to identify key production needs and special considerations.

Exhibit 1-2 provides an example of a Video design. This particular design is included for illustration purposes only.

Step 1.2 Review Presentation Designs

In order to ensure SHRP's acceptance and satisfaction with the presentations as they are developed, formal reviews will be carried out at key milestones during the project. The review of the Presentation Designs will be the first of these milestones and will be conducted in the following manner:

1. Copies of the Presentation Design will be submitted to the SHRP Steering Committee;

2. At least two weeks will be provided to allow sufficient time for SHRP to review the Presentation Designs and formulate its comments for revision;

3. Jorgensen's Principal Investigator will then meet with the SHRP Steering Committee to receive their comments;

Exhibit 1-2
VIDEO DESIGN

MODULE: POTHOLE REPAIR

PERFORMANCE OBJECTIVES

Upon completion of the video training module, the road maintenance supervisor will be able to: (1) identify the basic work steps in patching potholes permanently and (2) given the necessary resources, apply the work steps in actual pothole repair operations, using either premix or penetration materials.

CONTENT OUTLINE

I. INTRODUCTION

- A. Hazardous nature of potholes
  - 1. Vehicle wear and damage
  - 2. Potential accidents from swerving
- B. Causes of potholes
  - 1. Basic factors
    - a. Water seepage
    - b. Traffic loads
  - 2. Resulting pavement failure (by fatigue or raveling)
  - 3. Continuing growth of unrepaired defect
- C. Typical, inadequate patching approach
  - 1. Tendency to wait until large and numerous
  - 2. Hasty placement of patching material
  - 3. Little or no compaction
  - 4. Results
    - a. Displacement of patching material
    - b. Settlement of uncompacted material
    - c. Repeated water seepage and traffic loads
    - d. Frequent re-patching of same pothole
- D. More effective patching approach (overview)
  - 1. More timely repair on a high-priority basis
  - 2. Basic method
    - a. Step 1 -- Place safety controls
    - b. Step 2 -- Prepare hole, including:
      - 1) removing damaged material
      - 2) shaping hole for more stable patch
    - c. Step 3 -- apply tack, so that patch will stick
    - d. Step 4 -- Place and compact patching materials
      - 1) place materials in layers
      - 2) compact each layer
      - 3) for premix or penetration materials
    - e. Step 5 -- Finish and check final surface
    - f. Step 6 -- Clean up
  - 3. Results
    - a. Improved road surface
    - b. Greater permanence
      - 1) reduced overall cost
      - 2) less repeated work effort

II. DETAILED WORK STEPS

- A. Step 1 -- Place Safety Controls
  - 1. Importance of safety
    - a. For motorists
    - b. For workers
  - 2. Warning signs
    - a. For both directions of traffic

MODULE: POTHOLE REPAIR

b. Far enough in advance for adequate warning
3. Flagmen
4. Cones, portable barricades or other closure devices (if available)

B. Step 2 -- Prepare the Hole
1. Sweep out loose material
a. Broken pavement, dirt, mud, other debris
b. To see the extent of damage
2. Mark area to be removed
a. Beyond damaged pavement
b. In a generally rectangular shape
1) with squared corners
2) so that square tamper will fit in corners for proper compaction
3) if corners rounded or at acute angles, cannot get tamper in for proper compaction
4) not necessarily a perfect square -- adapt to shape of pothole
5) with 2 sides parallel to direction of traffic
3. Remove damaged material
a. Cut along edges
b. Break up damaged material within marked area
c. Using:
1) pick or cutting bar
2) jack hammer can be used, if available
4. Keep sides vertical
a. For support for the patch
b. If not vertical:
1) sides angled in -- poor compaction and edge breakage
2) sides angled out -- patch can shift out
5. Depth of hole
a. Deep enough to remove unstable material
b. Inspect base and repair as needed
6. Bottom of hole
a. Flat and level
b. For uniform layering and compaction
7. Sweep out loose materials (so that tack will stick)

C. Step 3 -- Apply Tack
1. Serves as "glue" to hold patch in place
2. Using:
a. Materials -- emulsified or hot asphalt
b. Tools --
1) asphalt kettle sprayer (if available) for large or numerous potholes
2) pressurized tack tank
3) can or dipper and broom (to spread)
3. Apply to sides (avoid excessive overlap on pavement)
4. Apply to bottom
a. If bottom in pavement or base
b. Sides only, if bottom in subgrade coverage
5. Proper, uniform coverage
a. Enough to cover, but texture shows through
b. Too much -- patching material will "float"
c. Too little -- patching matterial will not stick
6. Ready for patching material
a. For emulsion -- let tack break
b. For hot asphalt -- while still hot

D. Step 4(A) -- Place Premix
1. Hot or cold premix preferred, if available
2. Place in layers
a. Maximum depth of each layer -- 5-6 cm.
1) if hole only 5-6 cm., one layer

MODULE: POTHOLE REPAIR

2) if hole deeper then 6 cm., two or more layers
b. Placement sequence
1) corners and sides first
2) then in center
c. Spread each layer level with rake or float
3. Compact each layer
a. Using
1) hand tamper
2) vibratory plate compactor or air compressor tamper permissable if it will fit hole (if available)
3) truck tires or roller should not be used -- will break down edges of hole
b. Compaction sequence
1) start around corners and edges
2) work in to center
3) until thoroughly compacted
4. Repeat to just above surface
a. Placement of premix in layers
b. Compaction of each layer
c. (See Step 5 for finishing surface)

E. Step 4(B) -- Place Penetration Materials
1. When premix not available
2. Penetration materials
a. Hot or emulsified asphalt (as for tack)
b. Aggregates or "chippings"
1) course aggregate -- 3-5 cm.
2) key aggregate -- 2-3 cm.
3) cover aggregate -- about 1 cm. maximum
3. Place course aggregate
a. Provides foundation for patch
b. Place in a layer
1) around 5 cm. deep
2) around edges and then center
c. Compact layer
1) with hand tamper
2) from edges to center
d. Apply asphalt
1) enough to cover and penetrate
2) too little -- aggregates will not stick together
3) too much -- aggregates will float and slide
4. Place key aggregate
a. Helps lock course aggregate in place
b. Place in a uniform layer
1) about 2 cm.
2) so that combined course and key about 7 cm.
c. Compact layer
d. Apply asphalt
5. Repeat to just above surface
a. Composite layers of course and key aggregate
b. Compacting each layer
c. Applying asphalt
6. Apply cover aggregate
a. Enough to fully cover asphalt
b. About 1 cm. thick

F. Step 5 -- Finish Surface
1. Last layer before compaction
a. Slightly above (about 1 cm.) surrounding surface
b. Feather over surrounding surface, for shallow patch
c. Check with straightedge
1) longitudinal
2) transverse
2. Final compaction

MODULE: POTHOLE REPAIR

a. Hand tamper (if mechanic compaction not available)
b. If available --
   1) small roller (preferred)
   2) hand roller
   3) vibratory plate compactor, or
   4) wheels of truck
c. Sweep up loose material before final compaction, if roller used

3. Level of surface after compaction
   a. Check with straightedge
      1) longitudinal
      2) transverse
   b. Minimum level
      1) slightly above (less than 1 cm.) surrounding surface
      2) no depressions that can cause water to pond
      3) particularly if final compaction done with mechanical compaction equipment
   c. Maximum level
      1) about ½ to 1 cm. above surrounding surface
      2) to allow for traffic to compact further
      3) particularly if final compaction by hand
      4) but, do <u>not</u> create a bump

G. Step 6 -- Clean-Up
   1. Sweep up loose material around patch
      a. To avoid damage to vehicles from being kicked up by tires
      b. Avoid dislodging cover aggregate from binder (when penetration method used)
   2. Remove safety controls
   3. Clean tools and equipment at end of day
   4. If possible, when penetration method used
      a. Inspect patch the next day
      b. Check for any bleeding or stripping
      c. Apply additional cover aggregate or sand as needed

III. REVIEW

A. Timeliness of pothole patching
   1. On a high-priority basis
   2. Before potholes get too large and numerous

B. Basic work method
   1. Step 1 -- Place Safety Controls
   2. Step 2 -- Prepare the Hole, including
      a. Removal of all damaged or unstable material
      b. Rectangular shaping of hole for proper compaction
      c. Vertical sides and flat bottom
   3. Step 3 -- Apply Tack -- uniformly
   4. Step 4 (A) -- Place Premix (if available)
      a. Place in layers
      b. Compact each layer
   5. Step 4(B) -- Place Penetration Materials (if premix <u>not</u> available)
      a. Course, key and cover aggregate layers
      b. Compaction of each layer
      c. Application of asphalt
   6. Step 5 -- Finish Surface
      a. Flush with to slightly above surrounding surface
      b. Check with straightedge
   7. Step 6 -- Clean-Up

C. Advantages of proper pothole patching
   1. Improved road surface
   2. More permanent patching
      a. Reduced overall costs
      b. Less repeated work

MODULE: POTHOLE REPAIR

SUMMARY OF VIDEO TREATMENT

Introductory segment (of about 3 minutes) uses a combination of dramatic and motivational approaches. Module opens with close-up of vehicles hitting and swerving around a pothole to demonstrate hazards of potholes and therefore the need to patch these defects. In order to patch potholes effectively, we must recognize how they develop. A graphic sequence then illustrates water-seepage, traffic loads, pavement failure and continued pothole growth. A poor patching operation is then shown to demonstrate the tendency to wait until potholes are, large and numerous, causing a hasty method of throwing patching material into each hole without cleaning or shaping the hole, placing materials in layers or adequate compaction. The resulting displacement and settlement of material, continued water seepage and traffic and early failure of the patch are then graphically illustrated. A more effective approach is then previewed with emphasis on patching the pothole before it becomes a major problem, cleaning and shaping the hole, applying tacking, placing and compacting the material in layers and checking the finished surface. The results of this approach are then compared with those of the "hasty" approach in terms of the improved road surface and greater permanence of the patch -- with emphasis on reduced costs and less repetitious work effort.

The bulk (about 10 to 12 minutes) of the module then concentrates on demonstrating each work step of the more effective (permanent) pothole patching method in detail. For purposes of continuity and clarity, a single pothole patching operation (probably with premix) will be shown in close-up detail, from the unrepaired pothole to the completed patch ready for traffic. (A separate, but similar, pothole and patching operation will be shown for the major variation of penetration patching.) Scenes of the patching operation are supplemented with superimposed graphic symbols to emphasize key points or with fully graphic sequences to illustrate points that are not visually obvious from the actual patching operation (such as cross-sectional graphics to show the reasons for keeping the sides of the hole vertical or the importance of placing and compacting patching material in layers). Variations in the details of the work (such as different tools, equipment or materials that may be used) are shown in short video or still shots to supplement the basic method. Emphasis throughout the demonstration of the detailed work steps is placed on showing <u>how</u> pothole patching is done, with sufficient explanation of <u>why</u> it should be done that way to help motivate the trainee.

The final segment quickly (in about 1 or 2 minutes) reviews the importance of patching potholes before they become large and numerous, the basic work steps and key details that should be remembered. The module closes on a motivational note by reiterating the advantages of using the proper patching method in terms of the improved road surface and permanence of the patch -- with emphasis on the reduced cost and work effort resulting from a longer-lasting patch.

PRELIMINARY ESTIMATES OF PRODUCTION REQUIREMENTS

<u>Field Shooting Sites</u>:

#1 -- Relative large, isolated pothole (for hazards -- Content Outline #I.A) or possibly use Site #3 or 4

#2 -- Large and numerous potholes (for typical, inadequate approach -- Content Outline #I. C.)

#3 -- Isolated pothole, less than 3 feet in diamter (for primary patching operation with premix -- Content Outline #I.A. and D; #II.A., B., C., D., F., and G.; and III.A. & B.)

#4 -- Isolated pothole, less than 3 feet in diameter (for penetration patching operation -- Content Outline #II.E).

MODULE: POTHOLE REPAIR

Work Resources

Site #1 -- Vehicle(s) to hit and swerve around pothole

Site #2 -- Equipment & Tools
+ Truck (with premix)
+ Shovels

Materials
+ Premix

Crew
+ Driver
+ 1 or 2 laborers

Site #3 -- Equipment and Tools:
+ Truck
+ Warning signs, flags, closure devices
+ Brooms
+ Picks and shovels
+ Hand tamper
+ Tack applicator
+ Rake
+ Straightedge

Materials:
+ Reel or chalk
+ Base material
+ Emulsified or hot asphalt
+ Premix (cold or hot)

Crew:
+ 2-3 workers
+ 1-2 flagmen

Site #4 -- Equipment and Tools: (same as for Site #3)

Materials:
+ Emulsified or hot asphalt
+ Course aggregate
+ Key aggregate
+ Cover aggregate

Crew: (same as for Site #3)

Special Considerations

1. Developing countries generally use triangular-shaped warning signs -- may need to make a prop.

2. Local maintenance crews rarely use penetration method of patching and may be reluctant to stage it. May need to:

   a) make special local arrangements, or
   b) get sequence shot elsewhere.

3. Some basic types of tools or equipment commonly used in developing countries may not be available locally in U.S. May have to supplement with video tape or still photography from elsewhere. Samples of these include:

   + hot asphalt being "cooked" in used drum (in place of asphalt kettle)
   + can or dipper with broom (application of tack)
   + hand-pulled roller

4. Other variations in tools or equipment may require supplementary shooting locally or elsewhere, including:

   + air compressor with jack hammer,
   + asphalt keetle and sprayer,
   + air compressor tamper,
   + roller

MODULE: POTHOLE REPAIR

Production Resources

Field Video Equipment and Crew:

+ for Site #1 -- ½ day (or less)
+ for Site #2 -- ½ day (or less)
+ for Site #3 -- 1 day
+ for Site #4 -- ½ to 1 day

Graphic Production (still and animated) -- 7-8 days

Editing Equipment and Personnel -- 5 days

Narrator (off-camera) -- 1 to 1½ hours

4. The Principal Investigator will incorporate all revisions into the Presentation Designs during the meeting to ensure full concurrence and understanding of the changes being made; and

5. Copies of the revised Presentation Designs will be sent to SHRP for reference purposes after the review meeting.

Step 1.3 **Develop Draft Videotape Scripts**

The draft of the video modules will serve both as a written simulation of the audio-visual materials to be produced and as detailed guide for the production of the materials. The development of a draft for each of the video modules will include preparation of a storyboard, script and shooting plan.

Storyboard and Script

The storyboard and script will serve separate functions, with the storyboard concentrating on sketches of the visual as a general plan, and the script providing a description of the visual and the narration in written form. Jorgensen will use a coordinated storyboarding and scripting approach designed to maintain continuity between audio and visual elements. The storyboard card is formatted with written production notes, a sketch of the visual and the written narration placed side-by-side for each key visual event or scene, as illustrated in Exhibit 1-3. As the storyboard cards are developed they are organized into sequence, supplemented with additional cards to fill transitional or informational gaps, and modified as needed until the overall program is adequately represented. The cards are then numbered, assembled and photocopied for conversion to a script format as shown in Exhibit 1-4. In this manner, the sketch of the visual and other information from the storyboard can be maintained in the script for review and production reference.

Shooting Plan

The shooting plan will be developed as an expanded and more detailed version of the "Preliminary Estimates of Production Requirements" outlined in the Presentation Design. As the storyboard and script are developed, additional requirements and special considerations will be incorporated as they are identified. Preliminary arrangements will be made with local agencies for location sites and the use of their crews, equipment and operations in field shooting.

Step 1.4 **Review Draft Scripts**

The draft of each video presentation will then be reviewed with SHRP:

1. Copies of the script and shooting plan will be submitted to SHRP;

2. At least two weeks of lead time will be provided for SHRP review;

3. Jorgensen's Principal Investigator will meet with SHRP to receive comments and note required changes;

4. Revisions will be made during the meeting to the extent that it is practical; and

5. After all revisions have been made by the Consultant, copies of the revised draft will be sent to SHRP for review and approval.

Step 1.5 Produce Videotape Presentations

Production and post-production will be accomplished with state-of-the-art equipment and facilities. The list in Exhibit 1-5 lists the equipment and facilities provided. Production of the videotape will include the sub-tasks listed below.

Pre-Production Meeting. The purpose of this meeting is to review the final copy and storyboards approved for each segment and to discuss all important details. This activity allows for review of the concept and to discuss when and where the actual filming will be conducted. This meeting also includes discussion of any talent which will be screened and recruited for participation in the segment. Given the possible technical difficulty of some productions, actual sequences to be filmed may be blocked out in detailed discussion. We will issue a detailed summary, documenting all production notes regarding each segment to be produced. This serves as an important guideline for actual filming and is distributed to the client for detailed review and approval.

Location Selection. For location filming, the Project Team will scout alternative sites, and provide location reports including polaroid photographs, overall physical descriptions, cost and legal information, and other important details. Once approved by the client, arrangements to film at the selected location can begin.

Shooting. Arrangements will be made for all aspects of production activities, and a detailed shooting schedule will be prepared for review by the client. Once this schedule is approved, the actual production can begin. Jorgensen engineering and video production personnel will ensure that activities are performed in a technically correct manner and that each camera shot focuses primarily on item being discussed.

Provisions will be made for any recording on location which may be necessary, including sound effects to be used in the final edited versions of the modules. All such sound effects will be properly identified and labeled by an audio identification recorded on the original tape at the time the sound effect is recorded and by a brief description of the sound effect on the tape box.

Additionally, at the time of shooting, production still photographs can be taken of all the various scenes in the video segments. Prints of all photos as well as the film negatives can be provided to the client.

Editing. All materials will be appropriately slated. This includes Project Title, Agency Name, Contract Number, and Date.

The client may wish to be present during these editing sessions. We maintain a practice of accommodating clients during editing of all our productions.

Off-Line Edit. All of the initial edits are made "off-line" so that there will be an exact "frame count" guide for the final assembly.

Sound. Voice-over narration will be recorded in the sound studio with the assembled print as a guide. We use only "Professional" narrators. In a separate session, the separate tracks - ambient sound, voice-over, library music - are mixed and sweetened. This will result in a "Rough Cut" version of the videos.

On-Line Edit and Effects. Once the off-line edit and sound mix are completed, the on-line (final) edit is accomplished. Each segment will be mastered on one-inch "high band" (broadcast quality) tape. At this time "optical" effects are added. A typeface can be selected in the editing room and text is created through chyron. Special wipes, dissolves, and other effects are created through Quantel, ADO, or Mirage equipment. Virtually every imaginable effect needed for these presentations can be easily met in this manner.

Step 1.6 Review Videotape Presentations

The draft videotapes will then be reviewed with SHRP. A copy of the draft videotape and the necessary play-back equipment will be provided to the SHRP Steering Committee at least two weeks in advance of the review meeting. Key members of the Jorgensen team will be present to receive SHRP comments. Proposed changes will be identified and discussed to determine the most cost-effective means of revision that will satisfy SHRP's requirements. Out-take footage and other supplementary materials may be brought to the meeting to aid in this process.

Step 1.7 Finalize Videotape Presentations

The required revisions will then be incorporated into the videotape presentations. The comprehensive efforts made in the design, development and production of the presentations should limit these final revisions to such refinements as replacing small segments with other sequences previously shot in the field, minor modifications of graphics or narrative, additional graphic enhancement of field scenes and editing adjustments. However, additional field shooting will be undertaken to the extent that it may be required by the SHRP Steering committee.

The finalized master tape (one-inch masters) will then be submitted to SHRP. One-inch masters are necessary when multiple copies are to be distributed as is the case with this project. Estimated running times are 15 - 30 minutes for each videotape.

APPENDIX F

COST EFFECTIVENESS OF VIDEO TRAINING

Videotape Training For Highway Organizations Flexible and Cost Effective, Says Expert

ENG. OSCAR DE BUEN RICHKARDAY (standing), Operations Coordinator, Mexican Institute of Transport, introduces Tung S. Dong (center), Director of Technical Services, IRF, and Mercedes M. Pellet, Video Training Consultant, participants in the Third Latin American and Caribbean Road Maintenance Seminar.

Employees of a company using videotape for training for the first time were able to use the knowledge acquired immediately to reject 56 percent of the spare parts received in one shop because the parts were not within the specified tolerances. The result? By rejecting defective parts from the supplier, the company was able to realize an immediate saving of over 50 percent in the amount spent monthly on spare parts.

"Of course, if the defective parts had actually been used in a repair job, the cost would have been a hundred times that of the spare part," added Mercedes M. Pellet, Video Training Consultant, speaking at the Third Latin American and Caribbean Road Maintenance Seminar in Piriapolis, Uruguay, November 28–December 2, 1988.

The role of videotape training is especially important in the field of road maintenance, where broad-based theoretical training would be virtually useless. "Training as has been traditionally carried out—where one man works while six watch—is not sufficient. For training to succeed, it has to be job-related, practical and repeatable," said Mrs. Pellet.

She applied the concept that 'if you train a man to work, you've helped one man; but if you train a man to train others, you've helped the world,' to road maintenance.

"Why maintenance? Because if we cannot take care of what we have, we can never progress, we can never move forward. We will be forever rebuilding what we built yesterday." She continued:

Clearly, the need for road maintenance is singularly urgent. Money cannot be assigned to new roads until a comprehensive maintenance plan has been designed and implemented. An effective way to do that is to train people on how to do the job well—the first time; on how to perform maintenance tasks correctly and efficiently by applying the correct techniques and using the proper materials, equipment and tools; and on how to maintain and operate equipment so that it lasts longer and performs to the best of its capability. In brief, the only way is by training people to help themselves.

In equipment alone, the principal determinants of cost are equipment productivity, availability rates, and life cycle of the equipment. Through training, we can increase equipment productivity by training operators to perform road maintenance more efficiently. And greater equipment productivity means that fewer units will be required.

Through training we can also increase equipment availability rates. First, by improving the capability of mechanics to properly maintain the equipment. And second, by showing operators how to take proper care of their equipment, we can reduce equipment abuse. Both of these mean less downtime which, in turn, means that fewer units are required. Furthermore, improved capability of mechanics and reduced equipment abuse mean a longer equipment life cycle, thus requiring the replacement of less units each year.

At present, training can occur through the apprentice method or through the traditional classroom method. Unfortunately the apprentice method is ineffective and inefficient because few people are truly good teachers, and poor work practices can be transferred in the process. Also, the need for trained personnel far exceeds the numbers that could be trained on a one-to-one basis.

On the other hand, the classroom method has proved to be expensive and inefficient for teaching skills because it requires large central facilities and the need to pull the worker from the job for extended periods. In road maintenance the educational level of the work force makes it difficult for workers to sit in a classroom for extended periods and, consequently, they can't learn efficiently.

In our opinion, a solution that incorporates the old way of learning with the new technology is using videotape for training. Videotape allows the student to see the equipment and the processes first hand. Often he is able to see it better than he could if he were viewing the equipment directly, since the video camera can take the entire class into the plant and inside the equipment.

By observing an actual mechanic performing the job while hearing the explanation, the student is receiving the information through two senses, in the manner to which he is accustomed. The accuracy of the content is assured because the materials have been previously tested and verified. The videotape permits the student to rewind and review the materials as often as necessary to permit full understanding.

In addition to demonstrating the correct use of tolls and procedures, the videotape subliminally transmits work habits that are difficult to teach, and it does this by example. For instance, it demonstrates important aspects, such as the need for organization, safety and clean-

■ see VIDEOTAPE, p. 7

VIDEO, from p. 6

liness, which promote good work habits that are vital to good job performance. But videotape does this by fostering imitation through the visual representation of the advantages, rather than by exhortation.

Since the technical information is contained in a fixed presentation, every worker at every location and at any time receives the same work methods and procedures, regardless of the instructor's capabilities.

Mrs. Pellet used the International Road Federation's Videotape Training Library as a demonstration of the best use of videotape training, screening examples of the IRF tapes for the 120 participants in the Maintenance Seminar.

The IRF Videotape Library consists of 45 videotapes developed for use in the training of highway and public works personnel throughout the world. Details are available from IRF, 525 School St., SW, Washington, DC 20024, USA. ○

Table III*

Cost Comparison Between
Traditional and Videotape Training Programs

10 Initial Trainees

Videotape		*Traditional*	
Materials* - Videotape on one task	US $500.00	*Development of Program includes text and other materials**	US $2,890.00
Equipment	$1,000.00 (VCR)	Trainee Materials	
Instructor Preparation	$20.00 (2 hrs)*	Instr. Preparation	
Class Instructor	$50.00 (5 hrs)	Class Instructor	$50.00 (5 hrs)
	$1,570.00		$2,940.00
Cost/Trainee	$157.00	Cost/Trainee	$294.00

**Development of program cost does not include practical training*

Additional 100 Trainees: Six months later

Materials			
Equipment		Trainee Mat'l	$1,000.00
Instructor Preparation	$20.00	Inst. Preparation	$600.00
Class Instructor	$50.00	Class Instructor	$50.00
	$70.00		$1,650.00
Cost/Trainee	$.70	Cost/Trainee	$16.50

A year later 110 trainees have been trained at a total cost of:

Traditional Training = Cost per Trainee $41.73
Video Training = Cost per Trainee $14.91
A SAVINGS OF $26.82/trainee

And with video you still have the materials to train another 100.

**Note These figures are reflected as a representative sample only.*

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