# Research Implementation: Putting Research into Practice

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The Minnesota Department of Transportation (Mn/DOT) is an acknowledged leader within the research community. Currently Mn/DOT is being recognized internationally for both its Mn/ROAD and Guidestar programs; however, Mn/DOT does not always concentrate its research on high-volume roads. In fact, Mn/DOT and the Minnesota legislature have specifically created an organization to oversee and fund research for low-volume roads in Minnesota known as the Minnesota Local Road Research Board (LRRB). Although technology and innovation are important factors in research, communication is arguably the most vital step in the research process. This step, however, is often overlooked. Fortunately, Mn/DOT and the LRRB have funded an ongoing project to concentrate on specifically this issue—communicating research. This research project is known as Investigation 645, entitled "Research Implementation," the focus of which is to put research into practice. This paper will briefly chronicle the history of the LRRB, discuss and describe Research Implementation, and conclude with a description of some of the products developed under this project.

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## History of LRRB

Although Mn/DOT had a very active and industry-leading research department in the 1960s, many of its transportation leaders realized that there was a void in research conducted on low-volume roads. In recognition of this deficiency, the LRRB was formed in 1960 by the Minnesota legislature. The LRRB is funded through legislation with up to 0.5 percent of all municipal and county state aid funds going into its budget. At present funding levels, this amounts to approxi-

mately $1.6 million annually. In effect, this is a pooled research fund sponsored by the counties and cities of Minnesota.

The main focus of the LRRB is to fund research projects specifically for low-volume roads. In Minnesota a low-volume road is defined as one with an annual average daily traffic of less than 1,000 vehicles per day. Although the research is administered through the Office of Research Administration (ORA) of Mn/DOT, the actual research is conducted by both public and private agencies. The LRRB is governed by a committee composed of city and county engineers, Mn/DOT representatives (from State Aid, Physical Research, and ORA), and the University of Minnesota. Currently the LRRB is funding numerous research projects that are conducted by Mn/DOT, the University of Minnesota, and private consultants. The LRRB is also cosponsor of the low-volume test facility at the Mn/ROAD project.

## Investigation 645: Research Implementation

With so many agencies involved in research, not only locally but nationally and internationally, the LRRB sponsored Research Implementation in 1974. As stated earlier, the focus of this project is to put research into practice rather than conduct physical research. The benefits of this project are twofold:

- It communicates the findings, current practices, and state-of-the-art technology of the research topic. Rather than allowing research findings and information to be isolated at the sponsoring agency's office, a goal of this project is to communicate relevant information to the local engineers in Minnesota. In a sense, this project tries to prevent duplication of research by similar agencies.
- It acts as a reference source for local engineers. In an era of diminishing budgets and reduced staff, the products of this project act as an extension of the local community's engineering staff. Most of the products are a synthesis of current practices and technologies. The information is presented in a format that introduces and summarizes the topic and provides the additional resources for the engineering staff to consult for more specific or precise information.

Because of the importance and variety of topics this project encompasses, the LRRB commissioned an advisory committee to direct and oversee the project. The advisory committee, known as the Research Implementation Committee (RIC), mirrors the structure of the LRRB. Its members fall into the following two groups:

- Voting members
  - –Four county engineers,
  - –Two city engineers,
  - –Mn/DOT Assistant State Aid Engineer,
  - –One Mn/DOT District State Aid Engineer,
  - –Mn/DOT Technology Development Engineer,
  - –Mn/DOT Research Operations Engineer; and
- Ex-officio members
  - –Mn/DOT Research Implementation Coordinator,
  - –Mn/DOT Research Services Engineer,
  - –One representative from the University of Minnesota Technology Transfer Center (Minnesota $T^2$ Center),
  - –Others as appointed by the State Aid Engineer.

Members are appointed by the Mn/DOT State Aid Engineer with the concurrence of the Chair of the LRRB. Membership from local governments is reviewed on a 2-year cycle to allow others to have direct input and bring fresh ideas to the project.

The research is conducted by a consulting firm under a 2-year contract. The consultant is selected on the basis of knowledge of the research topics, qualifications, expertise, and, most important, ability to communicate research findings.

Communication is defined as a two-way exchange. The topics researched under this program are a direct result of the communication process—interaction between the researcher and the end users. Biennially, the RIC will survey the city and county engineers of Minnesota to determine their specific research needs. This survey process consists of an initial request to generate a listing of approximately 20 research topics. This list is then distributed to the city and county engineers of Minnesota. Minnesota has 87 counties and 117 cities with populations of more than 5,000.

The engineers are asked to rank each of the topics. The results are then tabulated, and through this coordinated effort, a list is made of 7 to 10 topics for research implementation projects. The success of this research project is largely a result of the direct involvement of the end users—the city and county engineers of Minnesota. To further continue the communication process, the current consultant has developed a process for creating subcommittees for each task. These subcommittees are composed of volunteers. At the beginning of the contract, the contractor mails out invitations to each of the county and city engineers of Minnesota. The invitation includes a copy of the project description for each topic and a request for assistance.

The premise for these subcommittees is "Why not use first-hand resources who have applied knowledge?" The response, involvement, and success of these subcommittees are a direct result of the effectiveness of the products developed under this project, products that go beyond the standard research report.

As stated earlier, this is not a physical research project. Rather than conducting a research experiment, the consultant is charged with synthesizing these research topics. The synthesis includes determining what is done locally, nationally and internationally with respect to the research topic, defining any special processes or concepts, providing any applicable case studies, and providing a list of available references to further educate the audience. One of the most important steps in this research process is defining the medium in which the results will be presented. Generally, this is done during the process of selecting a topic; however, based on research findings and direction from the RIC, the final medium often changes. Later in this paper, the various media are reviewed and discussed.

The typical research process includes a literature search and review; interviews with technical experts, practitioners, and researchers; research case studies; formulation of an outline; writing a draft document; review of the process (by technical staff, the subcommittee, the RIC, and the LRRB, in that order); and the final product. Involvement and interaction with the subcommittee for the topic is a continuous process. Typically, a topic is completed in 5 to 6 months.

Upon completion of the research, the information is communicated to the end users—the city and county engineers of Minnesota—through reports, documents, workshops, or videotapes. The communication strategy for each of the topics relies on interaction with potential users of the information. This interaction is a direct result of having the end users on both the RIC and subcommittees. Printing, duplicating, and distribution are handled by the Mn/DOT ORA. Distribution includes all Minnesota counties and each city with a population of 5,000 or greater, the Mn/DOT district offices and library, and the Minnesota $T^2$ Center.

The basic rule of communication is to identify and address the audience. For each topic primary and secondary audiences are identified. The products are developed and written in a context appropriate for the identified audience. In general, the primary audience has been the engineers (county and city or their staff) or the maintenance crews. The secondary audience has generally been the public, either in the form of the general public or the governing city and county boards.

Since the research implementation project started, a number of definable packages have been developed. The major areas of effort have been in pavement management, pavement maintenance and rehabilitation, pavement recycling, geotextiles, roadway stabilization, guardrails, speed control, and dust control. Though this is a broad area of topics, it is by no means a comprehensive list of the projects researched to date.

As stated earlier, the presentation medium is specifically selected for each topic on the basis of the material, audience, and required delivery style. Although numerous media have been used in the past, the three most common have been videotapes, reports, and workshops.

With respect to the videotapes, the LRRB determined that since these products were to deliver a broad but important series of messages, they should professionally address the concerns and engagingly deliver the message without sounding either too technical or too condescending. This goal would require hiring professional talent (such as writers and production companies). The LRRB made a significant financial commitment to the funding of the videos. Its investment has been worthwhile: several of the videotapes have won state and national awards. In addition, there have been numerous nationwide requests for them, and they are being shown on local cable television.

## Overview of Research Implementation Products

The following is a description of the products developed under this project, providing examples of the diversity of research topics and further illustrating the presentation media.

### Videotapes

The LRRB identified the need to communicate to the public the "hows" and "whys" of pavement design, construction, and rehabilitation. An important secondary goal was to convince citizens that they could trust their public engineers to make rational and supportable decisions. The LRRB was specific as to when and where this help was needed: the highly charged atmosphere of public meetings and hearings where publicly employed engineers must explain the pavement engineering process. It was clear that, in the context of a public meeting, the message would need to be delivered engagingly, quickly, and in language that the average citizen could understand.

The first videotape, entitled *Weather and Loads: The Effects They Have on Roads*, explains how pavement materials are affected by the forces of weather and loading. In the process, the viewer learns the basic concepts of pavement engineering, including fatigue, bearing capacity, and thermal expansion. For a technical topic and a general audience, it was decided that the on-screen moderator must be a well-known scientist. Accordingly, a popular local television meteorologist was selected. An essential component of this videotape is a set of cross-sectional pavement models. The on-screen moderator uses these tabletop models to show how pavement responds to weather and loading. Based on

research, the models were built to duplicate the responses of actual pavement materials.

"Seeing is believing" sums up the effect of this videotape on the viewer. Not only does the viewer come to understand some basics of engineering, but he or she also gains an understanding of the difficulty of the challenge faced by public engineers.

The second videotape, entitled *Road Repair: Do the Right Thing at the Right Time*, picks up where the first one leaves off. Again, the on-screen moderator was chosen carefully; however, a different style of presentation was chosen. A character played by a local actor was created. The character, Jim Johnson, is an average homeowner except for one thing: pavement rehabilitation is his hobby. Mostly by talking with his local engineer, Jim has learned a great deal about pavements. In the videotape, he explains what he knows in nontechnical terms. Using video clips, material samples of actual pavement, and many other visual aids, he shows the viewer how engineers gather data on pavement and underlying soils. Then he walks the viewers through a step-by-step discussion of the factors considered in making rehabilitation decisions.

The third videotape, entitled *Asphalt Crack Treatment: Helpful Information for the Road*, continues the message of the second videotape; however, it specifically describes one rehabilitation technique—crack maintenance. Because the techniques of and ideas on crack maintenance are so diverse, the presentation style was chosen carefully. The videotape is a dialogue between two ideologically diverse maintenance workers. One worker, older with little advanced education, has been a maintenance foreman for years; from experience he knows what works. The other worker, fresh out of technical school, has plenty of "book smarts"—he has read every research project available on crack maintenance but has no experience.

The dialogue is a gentle banter between the two workers sharing their respective knowledge: field experience and research technology. To effectively illustrate the dialogue, computer animation was used throughout. Additionally, the videotape shows the maintenance foreman taking the graduate out to a work site where he sees a demonstration of equipment used in a typical crack maintenance operation.

The fourth videotape, entitled *Sealcoating: A Matter of Science and Skill*, also continues the message of the second videotape; however, this time the specific rehabilitation technique is seal coating. Additionally, because this method of rehabilitation has a strong correlation with the effect weather has on pavements, the local meteorologist was brought back to be the on-screen moderator. The theme of this videotape is that in order to achieve a good-quality seal coat, both science and skill must be involved. The scientific discussion focuses on the necessity to design the seal coat. The discussion of the skill involved in the seal coat process addresses the application techniques.

An interesting point about this videotape is the coordinated effort between the research staff and the local engineering community. In order to produce the program economically yet provide the necessary film footage, local agencies were asked to provide film footage of their crews or to conduct their seal coating during times when a professional camera crew could be on site. Again the communication-interaction process was key in producing a high-quality product for this research project.

## Reports

Numerous reports have been produced as part of this project. Generally, a report is written for newer topics or topics that are fairly involved with many specific details, specifications, and regulations. The documents are written to serve as a single resource for that topic as a convenience to the user. An example of a report produced under this project is *Pavement Rehabilitation—A Guide for Minnesota Cities and Counties*, a three-volume manual to help agencies identify pavement deficiencies and select the appropriate rehabilitation. The main volume covers the theories and engineering principles of the rehabilitation process and was intended for use in the office. The two other volumes are field guides used for pavement distress identification, one for flexible pavements and the other for rigid pavements.

The main volume also includes the evaluation and design procedures for pavement rehabilitation. The evaluation emphasizes a number of variables or conditions that should be considered. The manual does not introduce any new technology. Thickness designs of new pavements involve two primary variables: traffic and soil strength. Rehabilitation design involves several additional variables such as pavement structure, condition, and strength. Rehabilitation design can involve more alternatives than new pavement design, which deals with materials, equipment, disruption of traffic, and work zone safety.

The manual was written as a working reference to help identify and classify surface distress, to explore various rehabilitation alternatives, to select an appropriate alternative, and to briefly describe the rehabilitation procedure. It provides standardized identification of distress types for both flexible and rigid pavements, calculation procedures for equivalent single-axle loads (ESALs), and a brief synopsis of the AASHTO thickness design procedure.

The two field-guide volumes are printed on a durable mylar-type stock in a convenient size for field use. Both

guides provide the following information on the various pavement distresses:

- Photographs showing the distress at low, medium, and high severity levels;
- Descriptions of the distress including what it looks like and how it can be identified;
- Detailed description of the three severity levels;
- Description of how to measure the distress; and
- Suggested rehabilitation and description of how the distress should be treated.

Because most distresses can be attributed to one of three main causes (insufficient strength, construction or material problems, and environmental effects), each distress is coded as to its most common cause. This coding is used to help the maintenance worker identify the cause of the distress rather than just fixing it. These guides were then used as the text for a workshop on pavement rehabilitation that was presented to Minnesota city and county engineers, maintenance workers, and supervisors throughout the state. This workshop is described later in this paper.

The following is a list of reports developed under the LRRB Research Implementation project in the last 4 years. It is evidence of the variety of topics encompassed.

- Crack Sealing Bituminous Pavements in Minnesota,
- Dust Control on Unpaved Roads,
- Infrastructure Management Software Use in Minnesota,
- Load Effects on Highway Pavements,
- Lightweight Fill Materials for Road Construction,
- Pavement Rehabilitation—A Guide for Minnesota Cities and Counties,
- Recycling of Pavement Materials in the 1990s,
- Repairing Utility Trenches,
- Statistical Calculations for Highway Material End Results Specifications,
- Synthesis on Subsurface Drainage of Water Infiltrating a Pavement Structure, and
- Waste Products in Highway Construction.

A report series developed specifically for this research project is called the Research Implementation Series (RIS). The RIS concept was developed to be quick-reference guides. These documents are usually 8 to 12 pages long and are stored in a three-ring binder at each of the city and county offices. The intent of the series is to quickly introduce the reader (county and city engineers or their staff) to the topic, provide general information about it, discuss current practices, and provide case studies and additional resources that can be used for more precise situations. In a sense the RIS is the *Reader's Digest* research guide. Currently, 19 RIS documents have been developed:

- RIS 1 Bituminous Pavements Using Sand Aggregates,
- RIS 2 Geotextiles in Highway and Road Construction,
- RIS 3 Geotextiles in Highway and Road Construction to Stabilize Shallow Fills,
- RIS 4 Geotextiles as Separation Layers in Highway and Road Construction,
- RIS 5 Geotextiles in Highway and Road Construction for Filtration, Drainage and Erosion Control,
- RIS 6 Geosynthetics in Reinforcement and Subgrade Separation in a Structural Section,
- RIS 7 Geosynthetics for Control of Crack Reflectance,
- RIS 8 Geosynthetics for Erosion Control of Slopes,
- RIS 9 Subsurface Drains for Minnesota Low Volume Roadways,
- RIS 10 Synthesis of Speed Control Devices,
- RIS 11 Insulation of Utility Trenches,
- RIS 12 Seal Coat Procedures and Problems,
- RIS 13 Subgrade Stabilization Procedures,
- RIS 14 Guardrails, End Treatments and Transitions,
- RIS 15 Waste Products in Highway Construction,
- RIS 16 A Synthesis of Measuring and Modeling Frost Depths,
- RIS 17 Vegetation Management,
- RIS 18 Herbicides, and
- RIS 19 Soil Stabilization of Low Volume Roads.

## Workshops

Workshops, seminars, and demonstration projects have been an interactive approach of communicating research findings. These functions are generally coordinated with the local $T^2$ centers. The workshops generally are requested by the local engineering community. After receiving the request, the LRRB will commission the research to be conducted for a given topic. Upon completion of the research, the workshop, seminar, or demonstration project is offered. As mentioned earlier, the workshop on Pavement Rehabilitation occurred in this manner. This workshop has been given numerous times throughout the state of Minnesota. Currently, a modified workshop is offered annually to train maintenance workers on pavement distress identification and repair.

In addition to working with the $T^2$ centers, other groups have been involved with cosponsoring workshops. For example, the U.S. Army Corps of Engineers

and FHWA cooperated to categorize the use of fabrics and document what type of fabric is appropriate for a given application. The late T. Allen Haliburton and his associates wrote a complete manual on the design and construction of projects using fabrics. He developed slides and set up a 4-day course for presentation of this material to engineers throughout the country. The purpose of this project, sponsored by FHWA, was to present the most up-to-date material on engineering fabric technology. The following is a list of several other courses presented as a part of Research Implementation:

- Statistically Based Specifications,
- Load Effects: Truck Effects on Pavements,
- Pavement Rehabilitation,
- Pavement Repair and Maintenance,
- Recycling, and
- Use of Fabrics in Road Construction.

## Summary

Minnesota has had a research implementation project for 20 years. The longevity of Research Implementation is an indicator of its success. As technologies change and new ideas become realities, there will always be a need to communicate these findings. Additionally, as the number of agencies conducting research increases, there will be a need to synthesize the results. Thus, Investigation 645—Research Implementation should continue to deliver high-quality products to the county and city engineers of Minnesota.

An indicator of the popularity of Research Implementation is the growing involvement of the local engineers. This voluntary involvement shows the importance and priority the local engineers give this research project. With busy schedules that border on the impossible, these public engineers are making time to be part of this project. In fact, in the last 4 years the local government engineers have made themselves or their staff available in areas of their expertise to help communicate their knowledge to their peers. From a marketing perspective, when the client is making this kind of sacrifice, the product is of high value. Research Implementation has furthered the national perception of Mn/DOT as a leader in research technology.

For additional information about the LRRB or the research project, contact the Mn/DOT Office of Research Administration.