

INVESTMENTS IN RESEARCH PRODUCE BIG PAYOFFS

MINNESOTA DEPARTMENT OF TRANSPORTATION

ROBERT BENKE

One of many projects undertaken by the Minnesota Department of Transportation, the low-sulfur rebar project is an example of investments in research that have potentially high payoffs. A study by the department supported the hypothesis that reducing sulfur inclusions in steel rebars can increase corrosion resistance. According to the principal investigator, the use of rebars with low sulfur content could extend the current average life span of bridge decks from 20 to as many as 70 years.

In 1996 the Minnesota legislature endorsed the value of projects such as the low-sulfur rebar investigation by enacting a change in state law that allows the Commissioner of Transportation to invest up to 2 percent of all appropriated funds (other than county and municipal state aid) for transportation research and technology transfer. In that 1-year period, Mn/DOT committed \$8,757,910 in state funds to research, development, and testing, and administered an additional \$4,683,379 in federal and local funds. Each year the department's research program becomes more diverse, with new partnerships being forged and new research areas being developed to respond to changing needs.

SETTING THE RESEARCH AGENDA

From bridges to repair of cracks and road pricing, topics for the department's research program come from a variety of sources. The department's Office of Research Administration works closely with the Commissioner's staff and the Office of Strategic Initiatives to identify emerging issues that require investigation. The Office of Research Administration also uses focus groups to identify research needs and priorities in functional subject areas. Within each research topic area, established research goals aid researchers in the preparation of their

proposals. These goals also assist decision makers in selecting specific research projects.

With increasing demands on the research budget, identification of projects that support strategic initiatives and anticipate future needs is increasingly important. Currently, the Office of Research Administration is developing a departmental research goal that will ensure that the research goals of the functional groups complement the department's overall vision and plans.

MAKING AN IMPACT

A review of some recent Mn/DOT research reveals the positive results of a thoughtful investment in research.

Environmental Services

Mn/DOT's Office of Environmental Services focuses on projects that better integrate highways into the environment and offer ways to reduce environmental impacts or to compensate for unavoidable impacts. In one project, the office tested the use of shredded tires in road construction, resulting in an improved protocol for assessing new materials. The new evaluation method transcends toxicological data gaps through the testing of complex chemical mixtures with living organisms and the measurement of the potential cumulative toxic effects. This technique results in actual biological measurements of toxic effects, eliminating reliance on standard theoretical evaluation techniques.

The Office of Environmental Services also pioneered the development of a nationally recognized technique for cleanup of soils contaminated by petroleum, the use of biomounds (see "Research Pays Off," *TR News* November–December 1994). Researchers applied a mixture of animal manure and wood chips to about 428 cubic meters (560

Robert Benke is director of the Office of Research Administration, Minnesota Department of Transportation

cubic yards) of petroleum-contaminated soil, creating a treatment pile known as a biomound. Similar to composting, the biomound treatment process makes use of petroleum-hungry bacteria found in natural products. After an 11-week treatment period, during which the bacteria feasted on the petroleum hydrocarbons, the hydrocarbon concentrations fell below cleanup thresholds specified by the Minnesota Pollution Control Agency.

Since completion of the initial research project, the department has saved approximately \$250,000 over costs for alternative methods such as thermal treatment. To date, the biomound treatment has been used successfully in Minnesota for soils excavated from more than 10 sites. The Environmental Protection Agency recently distributed a report to all states on the effectiveness of biomound treatment.

Bridges and Structures

Mn/DOT researchers have determined that concrete can be produced with 1-day strengths in excess of 96 527 kilopascals (14,000 pounds per square inch) and 29-day strengths in excess of 124 106 kilopascals (18,000 pounds per square inch). The ongoing research continues to help bridge designers determine appropriate ways to include higher-strength materials without compromising safety. As a result of this project, the department's Office of Bridges and Structures has specified the use of higher-strength materials.

Economy

The Minnesota freight flows study provides a comprehensive source of freight flow information in Minnesota and shows the ways in which the transportation system supports business and commerce. The study summarizes the freight flows in, out, through, and within Minnesota by mode and, in some cases, by major commodity and major origin or destination. This study was used to help construct the freight-related portions of the State Transportation Plan and was also offered as a national model.

Geographic Information Systems

Development of a geographic information system base map provides developers, government agencies, and the public with single-layer statewide data sets for transportation, water, political, and other boundaries. The trunk highway layer includes the route reference system. The base map has been published on CD-ROM.

Intelligent Transportation Systems

A wide-area video detection system, Autoscope™, which provides data from the roadway and monitors traffic flow, was developed at the University of Minnesota with state and federal funds. Autoscope™ helps manage urban traffic throughout the country. Its development led to the creation of a company called Image Sensing Systems, Inc., which develops and markets the product. Royalties from Autoscope™ sales will support research in traffic management technologies at the University of Minnesota.

Mn/DOT uses Autoscope™ for freeway traffic management. A road crew in St. Cloud, Minnesota, broadened the technology's application by using Autoscope™ to keep traffic moving safely during construction on one of the city's busiest streets. Autoscope™ monitored the flow and volume of traffic and operated traffic signals so well during construction that it will remain in use after construction is completed. According to the project engineer, Autoscope™ allows the department to do speed studies, make classification and turning movement counts, and collect other data that indicate the best use of the corridor's capabilities.

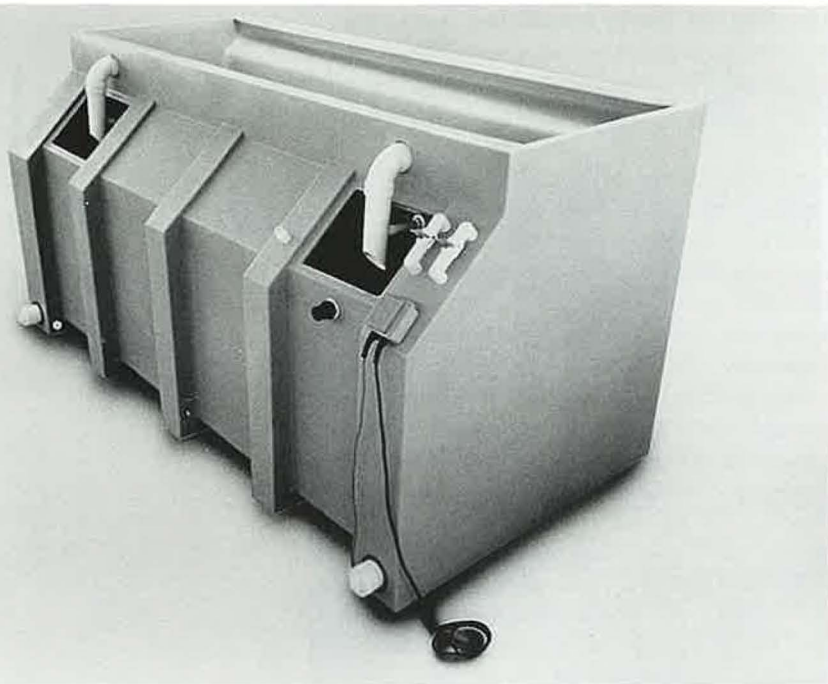
Intercity Transit

A recent study examined the reasons for declining use of for-hire, regular-route transit service between some cities. Members of the Minnesota legislature's House and Senate transportation committees reviewed this study as well as a follow-up study in 1996. This research is providing background for possible future legislation.

Maintenance

Mn/DOT has developed and evaluated several salt brine production systems (Figure 1). Its research shows that prewetted granular salt and salt-and-sand mixtures better adhere to the road, act faster, and work at lower temperatures to prevent snow accumulations. On-the-road research supports the conclusion that prewetting dry salt or salt-and-sand mixtures can reduce salt use up to 20 percent. Other field tests reveal that salt use can be reduced as much as 30 percent through zero-velocity spreading, correct calibration of sander controls, and continuous operator training.

Maintenance crews have also tested and evaluated the flashing Stop/Slow paddle, a product of the Strategic Highway Research Program that helps reduce the risk of accidents in work zones or traffic control areas. To implement use of the paddles, the department found a manufacturer to pro-



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FIGURE 1 Salt brine production system developed and tested by Minnesota Department of Transportation. Research revealed that prewetted granular salt better adheres to the road, acts faster, and works at lower temperatures to prevent snow accumulations.

duce them at a 25 percent savings, or about \$100 per sign, compared with current costs.

Minnesota Road Research Project

At the department's long-term pavement testing facility, known as the Minnesota Road Research Project (Mn/ROAD), researchers study and evaluate the performance of highway construction materials and investigate materials-related issues. In one project, researchers collaborated with staff of the U.S. Army Engineer Cold Regions Research and Engineering Laboratory (CRREL) to test and improve a new tool to measure frost depth.

The CRREL frost resistivity probe was designed to help engineers determine which roads may weaken or require weight restriction warnings in the spring. Mn/DOT's modified version of the probe allows engineers to more precisely and safely measure road frost depths. The device, which is being used at the pavement testing facility and several other locations, measures the critical thaw period more accurately than did older methods (Figure 2).

Railroads and Waterways

In 1995, after 16 persons were killed in accidents at some of Minnesota's 5,093 highway-railroad crossings, a study helped to identify the public's perception of railroad crossings and collected ideas for improved traffic control and a more effective safety program at these crossings. The

department has shared study findings in forums throughout the state, as well as made information available through reports and newsletters, and has developed an action plan to address the needs identified in the study.

Traffic Management and Traffic Engineering

Mn/DOT's Traffic Management Center has expanded its service by bringing 27 kilometers (17 miles) of remote ramp metering under adaptive control. The ramp metering system in the Minneapolis-St. Paul metropolitan area now includes 392 ramp meters, 164 closed-circuit television cameras, and 53 changeable message signs. A project to examine the effects of ramp metering will allow the department to better measure and improve the effectiveness of ramp meters throughout the state transportation system.

Transit

The city of Hutchinson, Minnesota, is a testing ground for a study of techniques to incorporate transit, bicycles, and pedestrians into local transportation systems. The study is aimed at examining the process of integrating transportation options into the city's planning and development process and at increasing public awareness of alternative transportation modes. In addition to potentially affecting Hutchinson's short- and long-term planning efforts, zoning policies, and traffic rerouting, the study may serve as a model for other cities nationwide.

REAPING BENEFITS THROUGH IMPLEMENTATION

Implementation of research results does not always run a smooth course. Take the case of the finding that low-sulfur rebars can extend the life span of bridges. As it turns out, these rebars are not commercially available in the United States, making their use by state DOTs difficult. As a result, the department has reworked its strategies for implementing use of the rebars and concluded that this effort may be best coordinated at the national level.

Investments in research are often exceeded by the benefits produced by the research. But, as the case of low-sulfur rebars indicates, reaping those benefits requires coordinated efforts and attention to technology transfer. Mn/DOT now emphasizes the latter by requiring researchers to consider implementation potential as part of the research proposal and planning process and by developing

special technology transfer tools needed to carry out implementation plans.

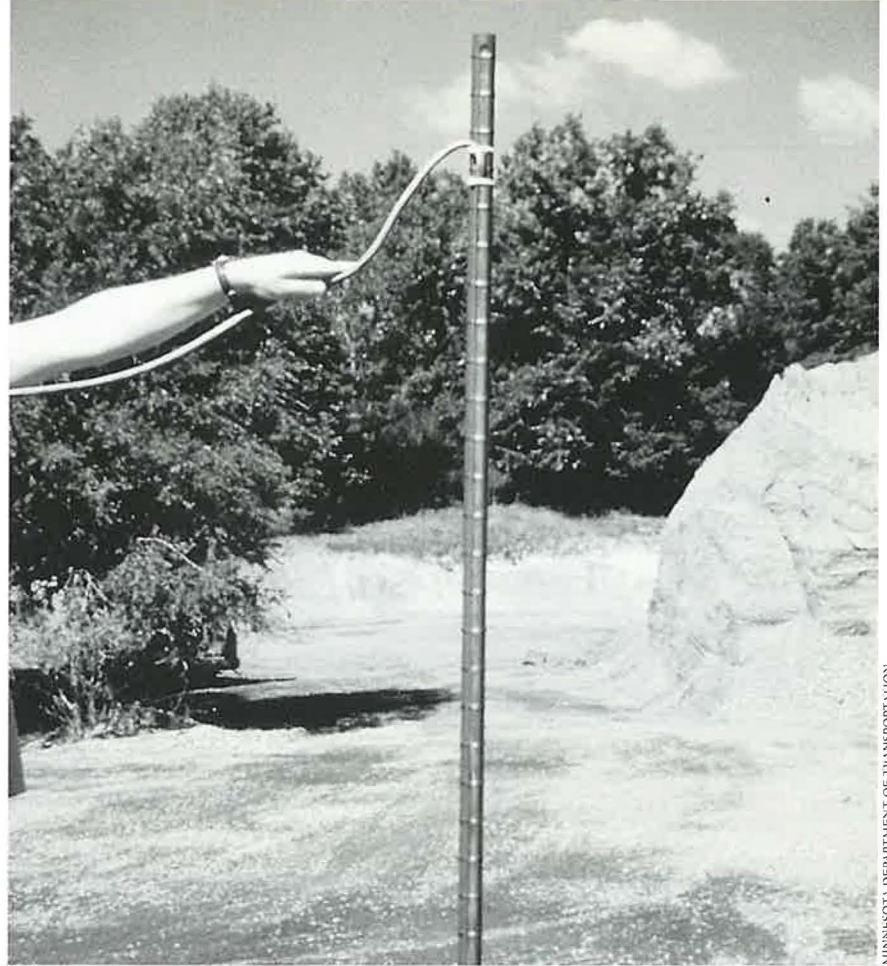
The department's Office of Research Administration operates a Technology Transfer^(T2) Program, which helps to facilitate and coordinate implementation of research results. The office brings together a network of research coordinators representing geographic districts and functional areas, the University of Minnesota, local-government transportation professionals, and private-sector consultants to work on issues related to implementation. Other technology transfer initiatives include developing a statewide transportation research data base and establishing a training program that will cover, in part, implementation and technology transfer. In addition, the office shares information about emerging issues with many audiences through special presentations known as Mindstretchers; topics have included congestion pricing, automated highway systems, methods of considering safety in highway investment decisions, innovative methods of public involvement, and federal deregulation of intrastate motor carriers. The office also supports technology transfer by collaborating with a technology transfer coordinating committee and other committees and organizations that assist with implementation. In addition, the office publishes documents that highlight the potential of research projects, develops guidelines and support for the writing of research implementation plans, and tracks and supports implementation efforts.

MEASURING THE EFFORT

Setting clear goals and planning for implementation at the start of research projects facilitates the next important task in a research program: performance measurement. Mn/DOT has developed key performance measures at both department and division levels and linked these measures to external and internal products and services.

The Office of Research Administration has identified three key elements in performance measurement: the ability to select the right research project, the impact of the results of research, and the effectiveness of research support activities. The right project is directly related to the goals of the department and its functional components and addresses problems that face sponsoring organizations. Any proposed project must be evaluated in terms of its estimated cost, possible benefits, and likelihood of implementation.

To measure implementation performance, the department must assess the significance of results to the department's constituents. This does not



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FIGURE 2 Frost resistivity probe refined by Mn/DOT is used to determine more precisely when to post weight restriction warnings in spring.

mean that theoretical research should not be undertaken, but rather that such research must support movement toward solving real and significant problems.

Research support activities can make all the difference between a report that collects dust on a shelf and one that initiates a change for the better. Some key support activities include selection of the researcher, formation of a research review panel, and development of a research implementation plan. These activities must be monitored to ensure that the research process stays on track.

To succeed, a research program also needs to operate with a degree of flexibility and openness to new directions and variation. Performance measures play a role in determining the program's effectiveness, but they should not overshadow the creation of an environment that fosters innovation. This year the department is receiving and reporting on the results of its first set of performance measures.

FOSTERING INNOVATION

Leadership and support for the department's research program come from the top. The Office of Research Administration helps lead the process to identify research issues and facilitates and

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OTHER MEETINGS

European Dynamic Interaction Vehicle-Infrastructure Experiment (DIVINE) Concluding Conference

September 17-19, 1997

Rotterdam, The Netherlands

Sponsors OECD member countries, the European Union through the Forum of European Highway Research Laboratories

Subjects Effects of dynamic loading on the design and maintenance of pavements, assessment of road-friendly vehicles, effects of dynamic bridge loading caused by heavy vehicles, computer models of dynamics of heavy vehicles, and options to improve the productivity of the road-freight industry.

Contact TNO-Road-Vehicles Research Institute, Vehicle Dynamics Department, P.O. Box 6033, NL-2600 JA Delft, The Netherlands (telephone 31-15-269-6411, fax 31-15-269-7314, e-mail hoogvelt@wt.tno.nl)

2nd World Conference on Emulsion

September 23-26, 1997

Bordeaux, France

Sponsors Colas S.A., CECA, L'Oréal, Rhone Poulenc, Ste Des Petroles Shell, Unilever

Subjects Formulation and preparation of emulsions, rheological characterization and long-term stability, emulsion behavior in usage, industrial applications, case histories, and new developments and constraints.

Contact CME, 50 Place Marcel Pagnol, 92100 Boulogne-Billancourt, France (telephone 33-01-47-61-7689, fax 33-01-47-61-7465)

Fourth International Conference on Safety and the Environment in the 21st Century

November 23-27, 1997

Tel-Aviv, Israel

Sponsors Ministry of Transport

Subjects National safety programs, road-user safety and road safety research, communication, road safety and group behavior, safety in the 21st century, town planning and environmental quality, transportation engineering, international and regional safety activities, and legal and medical aspects.

Contact Conference Secretariat, Dan Knassim Ltd., P.O. Box 1931, Ramat-Gan 52118, Israel (telephone 972-3-613-3340, fax 972-3-613-3341)

Ports '98

March 8-11, 1998

Long Beach, California

Sponsors American Society of Civil Engineers (ASCE), U.S. Section of Permanent International Association of Navigation Congresses

Subjects Port access, terminals, environmental concerns, transportation planning, and project delivery.

Contact ASCE, Conference and Exposition Department, 1801 Alexander Bell Drive, Reston, Virginia (telephone 800-548-2723 or 703-295-6029, fax 703-295-6144, e-mail conf@asce.org)

1998 FISITA World Automotive Congress. The Second Century of the Automobile

September 27-October 1, 1998

Paris, France

Sponsors International Federation of Automotive Engineering Societies (FISITA), Société des Ingénieurs de l'Automobile (SIA)

Subjects Automobile and planet, automobile and society, automobile and technology, and automobile and economy.

Contact SIA, 3, avenue du President Wilson, F-75116 Paris, France

TRB ON THE INTERNET [HTTP://WWW.NAS.EDU/TRB/](http://www.nas.edu/trb/)

For the most current information about TRB calendar events, visit the TRB web site. TRB's home page offers information about the organization and activities of the Board and its five divisions, information about how to become an organizational or individual affiliate, and access to on-line ordering of TRB publications. The site also includes a request for proposals through the National Cooperative Highway Research Program and the Transit Cooperative Research Program, lists upcoming TRB conferences and committee meetings, and provides staff e-mail addresses. In addition, the home page provides links to other transportation-related Internet sites including government, academic, and other organizations; career opportunities; glossaries; electronic publications; mailing lists and news groups; and software depositories and directories.

Minnesota DOT

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coordinates implementation. By acting as a research broker, the office matches identified needs with researchers and funding sources, manages research programs and projects, and supports the implementation of research results. It also tracks the benefits derived from the department's investment in research and, with the Mn/DOT library, which is part of the same office, works to develop innovative methods that improve the dissemination of research results and implementation information.

During the last few years, the scope of the department's research has expanded to reflect the social impacts of transportation decisions and the need for performance measurement. From strategic studies on older drivers to environmental challenges such as restoring wetlands, from road research on the chemical effects of deicing to maintenance studies on snow removal, from bridge piling stability research to traffic engineering speed studies, and from breakthrough innovations like stabilizing steep roadside slopes to developing a road weather information network, research helps Mn/DOT and its partners to find ways to be more responsive to customer needs.