PUTTING RESEARCH INTO PRACTICE

A Synopsis of Successful Strategies and Case Histories

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I. INTRODUCTION

"Progress...is not an accident, but a necessity.... It is a part of nature."

- Herbert Spencer, Social Statics, 1851

Building and operating a better transportation system is not simply a question of managing the existing system better. The key to progress is identifying promising new ideas and putting them into practice. The rate of progress will depend on how rapidly and successfully organizations can implement these new ideas. In fact, one of the marks of an organization that remains successful for a long time is its ability to foster and implement promising new practices, processes, and products — to embrace change and not fight it. Innovations come in many forms. Some come from vendors. Some come from basic research. And some come from within organizations themselves. A variety of innovations and sources of innovation require a variety of approaches to putting them into practice. But which approach?

Answering the question "But which approach?" was the focus of NCHRP Project 20-33. Through interviews, surveys, case history studies, and careful thought and evaluation, this project identified tips, techniques, strategies, and approaches to putting research results into practice. On the basis of research findings showing the same innovations taking hold in one locale, but failing in another, a fundamental conclusion of the study was that implementation strategies themselves, not the end product, often make the difference between success and failure. The excellent research performed for this project yielded valuable insights into the processes by which research is implemented. Some of Project 20-33's findings and recommendations might at first seem obvious. In fact, few of the findings are themselves surprising. The revelation of the Project 20-33 research is not the identification of any particular technique or approach for implementing research results; rather, it is how many of the individual strategies are needed to yield a successful result. As amply demonstrated by the case histories, implementing a single innovative idea can require the application of a half dozen or more specific strategies to successfully implement it.

This synopsis summarizes implementation practices leading to the successful and timely application of research findings, and illustrates the use of these practices in several case studies drawn from the research findings.

II. BACKGROUND CONDITIONS FAVORING INNOVATION

Need for Change

Implementation of new products or processes works best when there is a genuine need for change. For example, existing practices may be outdated and newer practices offer significant economic advantages or improvements in efficiency. Alternatively change may be mandated to meet new regulatory requirements or to reduce or eliminate persistent problems with existing practices.

Senior Management Support

Strong support from senior management can foster innovation and eliminate potential barriers to new products and processes. Senior managers can promote links among researchers, vendors and users; target funding; and commit the best qualified people in the agency to implementing research.

Tom Peters in his book *A Passion For Excellence* observes that innovation is a messy and unpredictable process. Such a process often runs counter to conventional management practices that attempt to plan and organize away the messiness and unpredictability of any process. Peters found that the success of innovation often depends on the efforts of a determined champion and the ability of an organization to allow for constant experimentation. In this context, managers must create ". . . a climate that nurtures and makes heros of experimenters and champions."

"The best leaders are apt to be found among those executives who have a strong component of unorthodoxy in their character. Instead of resisting innovation, they symbolize it."
- David Ogilvy

Adequate Resources

Sufficient funding and an expert or skilled staff are prerequisites for successfully implementing research. Management should allow time to develop an expert staff, recruit champions, reward their efforts, and publicize their successes to others in the industry. This will signal that putting research results into practice is an essential part of their staff's professional work.

III. STRATEGIES FOR PUTTING RESEARCH INTO PRACTICE

Target Research

The selection of problems for research should match users' needs. This implies that users must be a part of the selection process from the outset to express the objectives of the agency and to help prioritize research efforts. Users should be able to see the practical advantages of innovation in their everyday work.

Develop Goals

To successfully implement research, set clear goals for implementation whether the research goal is to achieve cost, time, and labor savings; meet new regulatory requirements, or replace outdated practices. Goals must be set forth and communicated to all parties involved in the implementation process.

The most frequently cited goals of putting research into practice are cost and time savings, labor savings, or improvements in performance. For example, major technological advances, such as the Superpave (Superior Performing Asphalt Pavements) mix design and analysis system developed under the Strategic Highway Research program (SHRP), offer the promise of substantially improved pavement performance at lower life-cycle cost. The goals of this innovation have been well defined and promoted to the paving industry, and the potential benefits are apparent to all parties. Beyond goals related to cost or time savings are goals related to new regulatory, legal, or safety requirements. These requirements result in improved practices, but the advantages may not be easily recognized or measured by those charged with implementing the change. The bottom line is that the implementation of research results can be messy, unpredictable, and difficult to justify to all parties. Developing flexible, comprehensive goals, and incorporating all the players in the goal-making process can help assure that the research results are implemented successfully.

Collaborate

Researchers and technical experts must be able to bridge the gap between theory-driven research and users' practical needs. When this happens, the technical merits of the innovation are grasped more quickly, mid-course corrections in the research can occur if necessary, and the final product is customized to users' needs.

Collaboration to implement research occurs in different forms. Researchers within a transportation agency may team with the implementers (users) in design, construction, maintenance, or other divisions of the organization to fine tune a new product or process. An agency may collaborate with a vendor or a contractor in the private sector, sharing resources to test, validate, and implement a new product or process. Finally, collaboration may occur between the agency and an outside research-oriented organization in the public or private sector, such as a technology transfer (T^2/LTAP) center, to promote and implement research findings for the entire industry.

To bridge the gap, individual researchers must spend time with individual users to understand their practical needs. Similarly, users must participate in the research process to implement it more effectively. Sharing knowledge, efforts, costs, and risks among key stakeholders can stretch resources, and improve interagency linkages and researcher-user linkages.

Conduct Pilot Projects

Successful implementation usually involves field tests, evaluations, demonstrations, or pilot projects. Users indicate that pilot projects conducted in real settings are essential to the success of many innovative ideas.

Collaborating with other agencies or the private sector and sharing resources such as the regional test centers set up by Federal Highway Administration (FHWA) for the SHRP implementation can spread the costs of conducting pilot projects, reduce the cost and time to implement innovations, and enhance confidence in the outcome.

Implement Multiple Strategies

Several strategies are more effective than one single strategy. Over reliance on any one specific strategy to promote innovation is unlikely to ensure long-term success.

Institutionalize Innovation

Agencies and organizations should commit funds in the annual budget for research implementation, dedicate a trained and expert staff to implementation efforts, and formalize interactions between researchers and users.

Continuing dialog between researchers and users should occur through periodic meetings of organizations or partnerships combining all stakeholders, through information exchange at national conferences and workshops, or through publications.

Allow Time for Implementation

Implementation activities are labor-intensive and require that multiple participants be involved for an extended period of time. New products or processes usually require fine-tuning or adjustment during implementation to realize the benefits. Stakeholders should view implementation efforts as a long-term commitment and evaluate success in terms of the life-cycle cost/benefit.

Obtain Feedback

Feedback from users in the field is essential to the long-term success of implementation. Feedback can be used to improve the new product or process and measure the benefits.

Recruit Champions

Finding and developing a champion to present and promote the expected benefits of implementation to users and policymakers will overcome inaction, change attitudes, and build widespread support for the implementation of new processes or products.

To maintain long-term and continuing support for the innovation, the benefits must be effectively communicated to policymakers and stakeholders, and publicized to the transportation community at large.

IV. LONG-TERM SUCCESS

"As the births of living creatures at first are ill-shapen, so are all innovations, which are the births of time."
- Francis Bacon

"All progress has resulted from people who took unpopular positions."
- Adlai Stevenson

Where are champions found? Technical experts within an agency are often recruited as champions. They may spearhead the development of a new technology or process, and also provide the impetus for implementing it. Managers from private or public sector organizations may also act as champions, changing attitudes and building support for innovation. A sponsoring organization such as the FHWA can act as an industrywide champion for implementing research. Lastly, the private sector may provide a champion to develop innovative materials or processes and promote them for the benefit of the industry. Champions are found in all facets of the transportation industry. When champions are recruited from different sectors of the industry and collaborate to implement research, the chances of widespread success become much greater.

"If you want the best things to happen in corporate life you have to find ways to be hospitable to the unusual person. You don't get innovation as a democratic process. You almost get it as an anti-democratic process. Certainly you get it as an antithetical process, so you have to have an environment where the body of people are really amenable to change and can deal with the conflicts that arise out of change and innovation."

- Max DePree,
Chairman and CEO of
Herman Miller, Inc.

This section summarizes several case histories taken from NCHRP Project 20-33 demonstrating the successful application of new products or processes in the transportation industry. The background conditions and strategies for success are highlighted in italics to the right of the narrative.

V. CASE HISTORIES

SHRP Superpave Mix Design

SHRP was established by Congress in 1987 as a 5-year, $150 million research program to improve the performance and durability of the nation's roads and make these roads safer for motorists and highway workers. From October 1987 through March 1993, $50 million of the research funds were allocated to developing new ways to design, specify, and test asphalt materials. The SHRP research in the area of asphalt materials resulted in Superpave. Superpave is composed of two parts: an asphalt binder technology and an asphalt mixture design and analysis system. The Superpave mixture design adapts to the unique environmental and traffic conditions of the project. Therefore, the mix produced is potentially more durable and the life-cycle costs are reduced.

Background conditions favor innovation

Funds allocated

Targeted research

In 1993, the FHWA assumed a leadership role in the implementation of SHRP research, particularly Superpave. This role included developing a National Asphalt Training Center, loaning binder-test equipment to regional asphalt user-producer groups, setting up a pooled fund among agencies to purchase equipment, setting up regional centers to conduct testing, and several other initiatives to implement Superpave among transportation agencies. The FHWA is currently evaluating Superpave at test tracks and pavement test sections throughout the country.

Expert Staff

Institutionalize innovation, collaboration, pilot projects

One transportation department learned about Superpave mix designs from research reports, journals, and professional and trade associations, and decided to develop a Superpave mix design to produce a cost-effective asphalt pavement with a lower life-cycle cost. The pavement design and research groups within the department initiated the program and actively participated in the SHRP research to obtain the final form of the mix design, and then spearheaded its use.

Champion

The department anticipates that the innovation will be successful because the product has the highest potential impact to the current state of practice and can yield the most investment return for the department. Pending further validation testing, the product will potentially generate a return much greater than the initial investment and implementation costs.

Seismic Retrofitting of Bridges

Immediately following the 1989 Loma Prieta earthquake, the Governor authorized a statewide review of the infrastructure and set in motion the implementation of innovative earthquake protection measures for all state infrastructure. The governor's task committee developed a seismic implementation strategy. This strategy included upgrading pier columns for bridges and other highway structures to meet the latest AASHTO guide specifications and FHWA guidelines for retrofitting existing bridges.

Conditions favor innovation

Implementation strategy to meet new requirements

The state transportation agency developed a number of options for retrofitting pier columns. The seismic retrofits included encircling certain columns with steel casing or, in some cases, using advanced woven fiber casing. The retrofits also included the installation of isolation bearings, and potential modifications to bridge footings, abutments, and restrainer units depending upon the site conditions. The agency allocated sufficient funding to test the options.

Funds allocated

To ensure that retrofitting options would work in a real setting, bridge engineers modified an existing bridge pier removal project to a pier retrofitting project in cooperation with the contractor. The agency used an open contract with the state university to conduct the seismic research to test the retrofit options and document the research. The agency also collaborated with several vendors willing to contribute innovative products and perform installations in return for accurate reporting of the retrofit system's performance in the department's product evaluation documentation.

A pilot project conducted in a real user setting

Collaboration

Following the installation of retrofits, the agency evaluated the retrofitted areas, including isolation bearings, for a 4-year period. Since the implementation, the retrofitted areas have experienced earthquakes of low magnitude. There have been no measurable signs of failure, and the agency is generally very satisfied with the result. Further development and testing of other innovative products for seismic protection of bridges and flyovers is now proceeding.

Benefits measured

Micro-surfacing

A city transportation department found that a number of streets paved within the last several years had become polished, causing slippery conditions and high accident rates. In response to public concerns, the department reviewed innovative alternatives to improve skid resistance and chose to apply micro-surfacing, an abrasive 3/8-inch slurry seal, in lieu of more established methods. Micro-surfacing is less expensive to construct, potentially adds 5 to 7 years to the roadway surface, and serves as a crack sealant.

Background conditions favor innovation

Targeted research

The department was approached by a vendor for micro-surfacing projects. The vendor offered extraordinary support and demonstrated the cost-effectiveness of the process.

Collaboration

The department programmed an initial project with three sites. Because of the good performance of the product, the agency decided to use the process on an annual basis. The department selects and prioritizes sites for micro-surfacing on the basis of police input, citizen complaints, and a department review of all city streets.

Pilot project

On the basis of its initial success, the department reserved special funds for annual micro-surfacing projects. The department has found that this innovation serves as a good public relations tool, saves construction money, prolongs the life of the roadway, and solves a serious safety issue for its citizens.

Funds allocated

Benefits measured and successes publicized

New Procedures for Removal of Lead-based Paint

Change mandated by new regulations

The Federal Occupational Safety and Health Administration issued new regulations to reduce the public's exposure to lead during the removal of lead-based paint from bridge structures. Previously, abrasive blasting caused the release of lead into the air, posing a hazard to workers and the general public. The new procedures consisted of enclosing the area undergoing sandblasting, using fans and filters to protect workers, and vacuuming lead particles at the end of paint removal.

Pilot project

Collaboration

A state highway department developed the new procedures in-house. The procedures were tested and refined through a pilot project. The department collaborated with the environmental and health departments to develop and implement the new paint removal procedures. This communication was essential for speeding up the implementation process.

Feedback from practitioners will improve the end product

Some members of the department and the contracting community expressed dissatisfaction with the new procedures because paint removal was more time-consuming and costly. Some smaller contractors went out of business because they could not make the capital investments now required. To address these concerns, the department is exploring opportunities to modify the regulations to distinguish between urban and rural areas and to reduce the burden on smaller contractors.

Benefits defined

The hazards of overexposure to lead are well documented, but the costs are difficult to measure. The new procedures achieved the intended benefit in terms of bringing the department's projects into compliance with the new regulations, and protecting the public and the environment.

Cathodic Protection for Coastal Bridges

A department of transportation became aware of the use of cathodic protection systems for coastal bridges from conferences and workshops, research reports and journals, vendors, consultants, contractors, and the FHWA. The department made extensive efforts to learn about "state-of-the-art" cathodic protection systems in other locations.

Targeted research

The department formed a technical advisory committee for research that included potential users. The committee chair issued periodic research unit reports regarding cathodic protection to other interested organizations within the state, other departments of transportation, and the FHWA. The expected benefits of the system were determined and "marketed" to potential users.

Collaboration

Use of champions

On the basis of positive results of the research, the department decided to implement the new system to extend the life span of coastal bridges, and installed a cathodic protection system on a coastal bridge in a demonstration project funded by the FHWA.

Pilot project

Following the initial project, several other cathodic systems were installed on coastal bridges in the state. The innovation was considered a success. Numerous historic coastal bridges that were deteriorating rapidly were saved from being replaced and the department saved millions of dollars in replacement costs.

Benefits measured

Adoption of "Thickness Design Manual" for New and Reconstructed Pavements

Changes have occurred in the area of pavement design in the past decade. The existing designs used by a state transportation agency were decades — as many as 80 years — old. No one in the department was familiar with the technical basis for the designs. Additionally, the FHWA mandated that each state highway agency develop a rational pavement design.

Change mandated by new requirements

Senior management committed to changes in pavement design. A senior manager participated in a European pavement tour, and set a course for implementing similar pavement design parameters in the state.

Senior management committed to the change

The in-house expertise of the research staff allowed the process of implementing the new design manual to move forward without delay. The department's research group conducted a life-cycle cost analysis to demonstrate the cost-effectiveness of the new design procedures. Though the new designs result in higher initial costs, the department anticipated an overall savings from longer-lasting pavements requiring less maintenance.

Expert staff

Benefits measured

The design manual was reviewed in detail by field personnel and the final version incorporated changes making the manual easier to use. The ability of the central office staff to work closely with researchers during every step of the process was instrumental to the success of the implementation effort.

Feedback from users improved the end product

Collaboration

The department has presented findings at professional meetings; published reports; and met with vendors, consultants, and contractors to promote the new design manual.

Success publicized

Falling Weight Deflectometer-Based Overlay Design

In response to a federal desire for improved pavement design procedures and a Pavement Management System, a department of transportation decided that it needed better data to support its pavement design procedures. Falling weight deflectometer (FWD) technology is used to measure the condition and performance of pavement designs over time. The equipment had been available for more than 20 years. The department's maintenance division purchased a FWD, but it was unused for 6 years. No one in the department had the expertise to use the equipment.

Change mandated by new requirements

When the department organized a pavement management unit, additional staff were hired with expertise in new technological areas or with motivation to try newer technologies.

Expert staff and champions recruited

In 1989, the pavement management group began to gain expertise in the FWD equipment, organizing a 3-year research project, testing 24 sections every 3 months. The group used the FWD to develop data on seasonal and temperature variations and changes in pavement conditions over time resulting from pavement distress.

Pilot project

On the basis of experience gained by the pavement management group, in 1900-1991 the department produced a written procedure for use of the FWD. With the dissemination of the written procedures and the continued development of expertise, FWD use in the state has increased. Currently, all projects on interstate highways use data from the FWD, except in a few areas (such as ramps) where traffic control prevents measurements.

Throughout the experience, the FHWA division office was very supportive and encouraged the pavement management unit to stand firm with its designs. The pavement management group laid the initial groundwork, overcame resistance to change within the organization, and continues to aggressively market the benefits of the FWD to division and district engineers. The department has instituted the use of FWD as standard practice, the equipment is used statewide, and the department has achieved its goal of developing a method for pavement design somewhat independent of engineering judgement.

Collaboration

Benefits publicized and promoted by champions

Bridge Management System

The Bridge Management System (BMS) is a computerized bridge maintenance system containing-operating programs and a database of about 17,000 bridges, culverts, and comparable structures in the state department of transportation's inventory. The input to BMS includes average daily traffic (ADT) counts and global assessments of the condition of each bridge, among other items.

The BMS began as a vision to create a systemwide bridge condition inventory database. A state department of transportation retained a state university to begin the system. The initial research began in the early 1980s and continued with seven contract research studies. The initial inventory data were generated in the early 1980s, and data analysis trials were done in 1985. Initial scheduling and budget allocations for the BMS were generated in 1989. The Intermodal Surface Transportation Efficiency Act (ISTEA) encouraged the development of a BMS for all states by January 1, 1995.

Targeted research

Collaboration

Change mandated by new regulations

The incremental approach to the research and development served to build confidence and acceptance in the BMS. It has been fully certified by the FHWA.

Incremental approach - time allowed for implementation

Top management was completely supportive of the incremental approach. The program pioneered the bridge management system. Once approval was given for the initial project in 1981, management and staff proceeded without interruption.

Senior management support

The department found that a major commitment from responsible managers and key technical people was required from the beginning. Also, implementation goals were established as early as possible, before the start of formal research. The department further concluded that policymakers and decisionmakers needed to be informed on a regular basis regarding the status of research to ensure the success of implementation.

Goals defined

During the initial development of the BMS, headquarters and field bridge maintenance staff were kept informed of the program. The maintenance staff made several useful suggestions, most notably to enhance the collection and quality of data.

Collaboration, feedback from users

A newspaper story in the early 1990s helped the bridge maintenance division receive more funding from the state legislature. The BMS has been more recently described or cited in numerous publications, including *Better Roads* magazine, research publications of the state university, and federal regulations.

Success publicized

The system has produced tremendous benefits. It continues to save a great deal of construction and repair expenses. Drivers have directly benefitted from fewer detours required by construction. Finally, the improved condition of the bridges has reduced the number of accidents.

Benefits measured

Additional case studies are highlighted in Appendix B of NCHRP Project 20-33 Final Report. Copies of this report can be purchased for $11.00 through the Transportation Research Board at the following address:

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