# FOREWORD

To better meet the highway infrastructure challenges of the 21st century, the Federal Highway Administration (FHWA) is refocusing and revitalizing its Infrastructure Research & Technology (R&T) Program to raise the bar on research, technology, and deployment activities. The overall goals of the program are to enhance mobility and productivity, extend the life of pavements and bridges, and improve safety and performance. The program also features increased emphasis on stakeholder involvement and partnerships to further enhance the effectiveness of the FHWA R&T Program. To share its Infrastructure R&T Vision with stakeholders and to build stakeholder commitment to achieving infrastructure innovations, FHWA held an Infrastructure R&T Stakeholder Workshop in Chicago, Illinois, on October 31 and November 1, 2002. More than 60 representatives from highway agencies, associations and industry, and academia participated in the event. This report documents the Stakeholder Workshop discussions and recommendations. The comments and recommendations will be used by FHWA to revise and sharpen the Infrastructure R&T vision and to further define future stakeholder involvement.

This report will be of interest to highway managers; engineers involved in design, construction, and operations; and researchers. The report is being distributed to the workshop participants, as well as to the broader highway community.

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16. Abstract
To meet the highway infrastructure challenges that lie ahead, the Federal Highway Administration (FHWA) is refocusing and revitalizing its Infrastructure Research and Technology (R&T) Program to raise the bar on research, technology, and deployment activities. This program represents a new way of doing business for FHWA, with increased emphasis on stakeholder involvement and partnerships. The overall goals of the program are to enhance mobility and productivity, extend the life of pavements and bridges, and improve safety and performance. These goals require investing in four essential elements: information, people, technology, and deployment.

To share its Infrastructure R&T Vision with stakeholders, FHWA held an Infrastructure R&T Stakeholder Workshop in Chicago, Illinois, on October 31 and November 1, 2002. The workshop drew more than 60 representatives from highway agencies, associations and industry, and academia. The workshop was designed to give FHWA an opportunity to listen to stakeholders in order to refine its vision and to build stakeholder commitment to achieving infrastructure innovations. This report documents the Stakeholder Workshop discussions and recommendations. FHWA will use the workshop discussions and recommendations to revise and sharpen the Infrastructure R&T vision and help to define stakeholder involvement.

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# INTRODUCTION

From personal travel to trade and commerce, highways form the backbone of the U.S. transportation system. As the traffic volume increases each year, however, and the highway system ages, the challenge of improving this system to meet the growing demands becomes greater, requiring innovation and a willingness to move beyond the status quo. Vital to meeting the infrastructure challenge is launching the long-term, high-risk, and high-payoff research that will yield the necessary breakthrough technologies of tomorrow. A number of new technologies are available today that can improve the safety, efficiency, reliability, and durability of the Nation's highways; effectively deploying both existing and new technologies is key to meeting

these challenges.

To meet the challenges that lie ahead, the Federal Highway Administration (FHWA) is refocusing and revitalizing its Infrastructure Research and Technology (R&T) Program to raise the bar on research, technology, and deployment activities. This program represents a new way of doing business for FHWA, increasing emphasis on stakeholder involvement and partnerships. The overall goals of the program are to enhance mobility and productivity, extend the life of pavements and bridges, and improve safety and performance. These goals require four essential investments: information, people, technology, and deployment.

Reliable information is essential to support transportation investment decisions and the development and deployment of new technologies. Managers, technicians, engineers, and others must be equipped to carry out their jobs. Advanced technology and innovative thinking are needed to achieve the technology breakthroughs that will carry us well into this new century. And once these breakthroughs are achieved, deployment efforts are vital to turning innovative research into everyday practices. FHWA's role in accomplishing these essential actions will include providing leadership and national coordination; addressing longer-term, higher risk research; filling critical research gaps; and providing deployment and technical assistance. Realizing the full infrastructure R&T vision, however, will depend upon strong and continuing partnerships with stakeholders.

To share its infrastructure R&T vision with stakeholders, FHWA held an Infrastructure R&T Stakeholder Workshop in Chicago, Illinois, on October 31 and November 1, 2002 (see Appendix C for the workshop agenda). The workshop drew more than 60 representatives from highway agencies, associations and industry, and academia (see Appendix D for the roster of attendees). The workshop was designed to give FHWA an opportunity to listen to stakeholders in order to refine its vision and to build stakeholder commitment to achieving infrastructure innovations.

## FHWA INFRASTRUCTURE RESEARCH AND TECHNOLOGY VISION

FHWA is proposing a refocused and revitalized Infrastructure R&T Program to set a strategic direction for developing and deploying breakthrough technologies for highway infrastructure. The proposed program includes the critical elements of information, people, technology, and deployment in the areas of asset management, structures, and pavements. The infrastructure R&T vision white paper (see Appendix A) presents FHWA's preliminary thinking on the structure of the program.

The Infrastructure R&T Program emphasizes stakeholder involvement and partnerships. The entire highway community; Federal, State, and local agencies; national organizations; private industry; academia; and others will have to work together to solve increasingly complex highway infrastructure issues. FHWA is committed to increasing stakeholder involvement in the program.

Before the workshop, FHWA provided the participants with a copy of a white paper, which served as a "straw man" and a point of departure for discussions at the workshop. The paper is but one step in an ongoing and evolving process that included the workshop, a session at the 2003 TRB Annual Meeting, and continuing outreach efforts. FHWA's intent is to create a structured, systematic process that will ensure strong stakeholder participation in all phases of the Infrastructure R&T Program.

Workshop participants heard presentations from FHWA on the Infrastructure R&T Program. Following the presentations the participants were formed into four breakout groups: asset management, structures, pavements, and stakeholder involvement. During the breakout sessions the participants discussed the proposed program and developed observations, conclusions, and recommendations.

The next section briefly describes the groups' discussions.

## BREAKOUT GROUP DISCUSSIONS

The four breakout groups met over the afternoon of the first day and morning of the second day. In all, each group met for more than 5 hours.

### Asset Management

In the asset management area, stakeholders outlined a vision of promoting new and improved decision making by developing the tools, data, and training necessary to support implementation. The group noted that asset management is a holistic process where decisions cut across asset classes, functions, and even modes. They further indicated that the focus of FHWA's activities should be on supporting the implementation of asset management, as opposed to creating a new decision making framework; the principles are not new, just difficult to implement, especially in their entirety. In answer to the question,

"Why are we promoting asset management?," the group indicated that it was to improve customer service.

The group discussed the importance of making information available to support the trade-off analysis required for asset management: The integration of disparate databases, the ability to predict performance, and the availability of highway user and societal costs were seen as important types of information for asset management. Participants were concerned about the cost (e.g., for georeferencing), institutional issues (e.g., who owns the data), and the myriad issues and complexity levels faced by each transportation agency. They also wanted to see reliable, accurate, and rapid methods for collecting data on infrastructure condition. The group highlighted the importance of helping agencies avoid information overload by identifying the key data items and the minimum level of information required to conduct asset management. They suggested that better methods be developed to connect demand, condition, and risk. Also of interest was work to quantify customer satisfaction. In addition, the group discussed making the data elements collected more responsive to the needs of decision makers.

The resounding theme in the "people" focus area centered on expanding the target audience for FHWA's awareness program. The consensus was that the agency had done much in this area, but still had a long way to go. It was suggested that FHWA work to reach its own internal staff, particularly its Division Administrators, the business community, consultants, and legislators. With respect to education and training, FHWA heard that it needed to expand the target audience, again to include departments of transportation (DOTs), consulting firms, academic faculty, other trainers, and students from disciplines in addition to engineering. Recommendations included: identifying alternative training venues (such as the Internet and onsite locations); supporting the development of near-term training programs, certificate programs, and university programs; and providing material for trainers, students, and practitioners. The group also discussed the fact that asset management is multidisciplinary; it therefore is critical to show how the silo knowledge and management systems relate to asset management. There was a suggestion to develop an FHWA internship program where FHWA employees would work at State DOTs.

Technology is the bridge that makes asset management useful. As in the discussions in the information focus area, the group talked about technology to support trade-off analysis. This includes the need to link management systems, incorporate risk analysis in the decision making process, and interface with all the functions in an agency (for example, operations, safety, human resources, and finance). The group proposed that FHWA undertake a program of developing technology for data integration and data sharing that could be applied at a relatively low cost in individual agencies. The stakeholders saw FHWA as uniquely positioned to take on this difficult but important task. It was noted that transportation agencies are not necessarily aware of the tools/technologies currently available. The idea for an FHWA "consumer reports" for tools was raised as a way to fill this gap. There is a perception that FHWA is not taking advantage of the capabilities at its Turner-Fairbank Highway Research Center (TFHRC) facility with respect to asset

management, nor adequately coordinating with the offices of pavement and bridge technologies. The notion that homeland security should be an aspect of the analytical tools was advanced.

Observations on deployment included the suggestion that FHWA should capitalize on one of its unique strengths, its field structure. To accomplish this, the group suggested that FHWA activate an internal deployment program. Significant discussion focused on the importance of identifying options that State and local governments and transportation agencies might explore to institutionalize asset management. It was noted, for example, that in Michigan and Vermont a requirement for asset management was legislated. The group recommended that FHWA develop an executive information system to show the information available and help decision makers make decisions. Finally, the stakeholders talked about demonstrating the benefits of asset management as a means for supporting deployment. The group stressed that the deployment process should include deployment of the asset management approach, not just the tools.

**Structures**

Structures stakeholders stated that goals should be realistic. A reasonable objective timeline should be mapped out. Some participants emphasized that the new R&T approach should not leave incrementalism behind. It was also stressed that a fundamental objective should be to minimize the impact of structures work on highway users. National coordination of current knowledge is needed, such as through a clearinghouse. Fabricators and contractors should be involved, as well as engineering/technology societies. It was suggested that FHWA initiate forums and workshops for industry and public agencies on ready-to-implement technologies and fund travel for State highway participants. There should also be better criteria for R&T project team selection to ensure that the best people are chosen for large projects. Questions raised include looking at whether the proposed long-term bridge performance program is a good use of resources. It was noted that the methodology for measuring the reliability of the intended performance of structures needs to be mapped out (according to the stakeholders, FHWA is probably the only organization that can do this). Developing training for Load and Resistance Factor Design (LRFD) implementation also must be an emphasis. The development of LRFD specifications for new materials, such as fiber-reinforced polymer (FRP) composites, also must be addressed. When it comes to research, existing structures, facilities, and expertise should be used. And unusual loadings/catastrophic events (both human made and natural) should be categorized.

A national process should be set up for communicating with stakeholders on a regular basis. Stakeholders need to be aware of what research is going on and the status of deployment efforts. An FHWA liaison should be designated for each technology and R&T program. At the same time, FHWA bridge engineers should keep States aware of what is going on with the R&T program. Also, stakeholder involvement should be designed for various stakeholder interests (e.g., urban vs. rural). Finally, FHWA should assist highway agencies in implementing State-developed innovations.

**Pavements**

In initial open discussions, participants noted that success demands champions who will develop constituents for the program. A formal process should be set up to communicate the contents and progress of the program to stakeholders. On the information side, data should be collected on the cost and benefits of technologies; this will help the deployment process. State-of-the-art case studies and best practices should be compiled and distributed to help stakeholders make optimal pavement-related decisions.

More structured discussions followed on the proposed framework for the program, the technical contents of the program, and areas needing emphasis.

In the area of program framework or process, the group noted that specific desired outcomes of the program should be defined. Some participants expressed concern as to how the resources, including both funding and effort, would be allocated within the program. A timeframe for transition to the proposed program is needed to maintain stakeholder interest in the proposed new approach. The proposed role of FHWA, including pursuing higher risk, longer term research, filling gaps, and serving a leadership and coordination function was considered appropriate. The process should deal with certain policy barriers so that construction funds could be used for demonstration projects and innovation. To help remove barriers, the group recommended that innovation become an area of emphasis throughout FHWA. Stakeholder involvement needs were passed on to the stakeholder breakout group for their consideration

A number of suggestions were made for the technical side of the program. In the area of design systems, pavement design should be treated as a system of the various component parts, not just structural design or mixture design. Extending the use of local materials is needed in this design system. Better performance-prediction models and traffic-loading prediction procedures are needed. The Long-Term Pavement Performance (LTPP) process and gaps in the database need to be evaluated carefully. Training activities need to address the existing agency and contractor workforce, as well as university curricula for new graduates. Technical areas that need to be added to the program are consideration of pavement management and maintenance and rehabilitation strategies.

**Stakeholder Involvement**

The stakeholder group noted that the key to making FHWA's R&T program work is stakeholder involvement. The primary question noted was, "How can we get a durable and lasting process to formalize stakeholder involvement?" Suggestions relating to this process included identifying and inviting other transportation modal participants to be involved, as well as placing more emphasis on education. Reciprocity between modal agencies should be encouraged. Also, stakeholders should have a very structured role.

Participants observed that long-term research is important, but so are intermediate results. Research needs to be coordinated. Also, communicating with stakeholders is important. Practice communities could play a role here. It also was noted that different levels of stakeholders exist: Some are leaders who can define the agenda and support or identify risks, while others are the ones who apply the technology.

Participants also commented that if there is going to be long-term, fundamental research, then FHWA must be the one to do it, because States are losing their internal research capabilities and must depend on universities. A major challenge lies ahead in regard to advancing the infrastructure knowledge base. It was decided that fundamental research was an appropriate goal. Support was expressed for the recommendations made in *Highway*

*Research: Systematic Selection and Evaluation Processes Needed for Research Program* (General Accounting Office Report GAO-02-573):

- Develop a systematic approach.
- Devise a process for significant peer review.
- Generate plans for implementation.

The group expressed the opinion that achieving these goals would require the conduct and coordination of research and the ongoing work of TFHRC. Also, more outreach is needed to let people know the results of research.

Finally, it was suggested that stakeholders be divided into three groups: strategic, program, and project.

## BREAKOUT GROUPS CONCLUSIONS AND RECOMMENDATIONS

The breakout groups presented their conclusions and recommendations to workshop participants on November 1.

### ASSET MANAGEMENT

In the asset management area, stakeholders recommended that the FHWA Office of Asset Management change its vision statement to stress its role as supporting the implementation of asset management through providing the necessary tools, data, and training. Participants also indicated that the office should recognize customer service as the primary driver of asset management, as opposed to just return-on-investment. The group confirmed that FHWA should not own the movement toward asset management, but should be a partner. Stakeholders validated the strategies and activities presented in the proposed Infrastructure R&T Program, but suggested numerous additions. An overarching theme in these suggestions was increasing FHWA's target audience, particularly to involve FHWA field staff. Key recommendations include:

- Integrating disparate databases.
- Improving predictability models.
- Estimating highway user costs and costs to society.
- Providing material for trainers, students, and practitioners.
- Recognizing the multidisciplinary nature of asset management and striving for better coordination, perhaps through creation of an asset management institute.
- Identifying options for institutionalization of the process.
- Working to interface asset management with functions such as operations and human resources.
- Demonstrating effective decisions made using the process.
- Showing how the asset management results are used.
- Developing a marketing strategy to convey the asset management message.

The stakeholders recommended that resources be allocated as follows:

- Technology—24 percent.
- Information—26 percent.
- Deployment—27 percent.
- People—23 percent.

Money should be split between research and development (R&D) and deployment.

## STRUCTURES

Suggestions for structures R&T included:

- Setting short- and long-term objectives for achieving the bridge of the future and clarifying the timeline for achieving objectives.
- Expanding the R&T vision to include rehabilitation methods.
- Emphasizing the importance of minimizing the impact on the traveling public.

Stakeholders recommended that FHWA continue and emphasize its role in training and assist States by providing models for managing R&D programs and sharing best practices. It was also suggested that FHWA take a leadership role in collecting and disseminating research in progress and research results from all sources, and it was noted that further stakeholder involvement in refining the FHWA Innovative Bridge Research and Construction (IBRC) Program is desired. While the group agreed that the FHWA proposal generally had merit, there were concerns about the format proposed, such as the long-term bridge-performance program.

## PAVEMENTS

Pavements stakeholders emphasized that specific outcomes for the R&T program should be defined. Emphasis areas should include pavement system design, performance-prediction models, traffic prediction, pavement management, and maintenance and rehabilitation. Training should target highway agency and contractor employees, as well as universities. In addition, LTPP program data gaps should be filled, and FHWA should analyze proactively the available results. When it comes to stakeholder involvement, a formal process should include both program and project level input. Also, all pavement plans and ideas should be environmentally friendly.

## STAKEHOLDER INVOLVEMENT

The stakeholder group recommended three levels of stakeholder involvement: strategic, programmatic, and project. These levels would encompass such roles as: providing merit review of research and technologies at the project level; establishing criteria for creating R&T program areas at the programmatic level; and serving as a steering committee at the strategic level. Participants supported the recommendation that FHWA continue to both conduct and coordinate research. Other recommendations included specifically addressing security issues, emphasizing outreach and education and training, and recognizing the importance of integrating practice with research. Also, institutional issues (such as setting up matching and pooled funds and establishing public/private partnerships) need to be addressed. Some stakeholders noted the need to define the context of highway infrastructure and to accommodate nontraditional areas of research.

## BREAKOUT GROUP PRESENTATIONS

The November 1 Breakout Groups' Microsoft PowerPoint presentations are shown in

Appendix B.

## INFRASTRUCTURE RESEARCH AND TECHNOLOGY PROGRAM NEXT STEPS

The proposals presented at the FHWA Stakeholder Workshop in Chicago, Illinois, represented FHWA's current thinking on the direction that the Infrastructure R&T Program needs to move over the next decade or longer to achieve the vital strategic goals of increased mobility, reduced congestion, and improved safety. As outlined at the workshop, the proposed focus is on the longer term, high-payoff research-and-development activities. We intend to develop and deploy breakthrough technologies that have the potential to change our expectations about pavement and bridge performance, as well as the way we manage our infrastructure systems. Achieving these breakthroughs will involve the critical elements of information, people, technology, and deployment.

As the workshop detailed, we are proposing to refocus our direction, ultimately achieving a fundamental change in the way we manage this research and technology program. The most significant aspect of this change is expanding the role of stakeholders: We aim to involve stakeholders in every aspect of the R&T process. The stakeholder workshop was a first step, as well as a checkpoint to ensure that we are going in the right direction. The feedback and input received at the workshop will help us revise and sharpen the infrastructure R&T vision and help to define stakeholder involvement as we move forward to carry out this vision. The results of the workshop and our initial thinking on formal stakeholder involvement models were presented in Session 284 during the January 2003 Annual Meeting of the Transportation Research Board.

**During 2003, as FHWA gears up for reauthorization of the Transportation Equity Act for the 21st Century (TEA-21), we will continue to refine the Infrastructure R&T vision statement and stakeholder involvement model. This will be done by building upon the recommendations from the Chicago workshop, input received from the session held during the Transportation Research Board's 2003 Annual Meeting, and via continuing dialogue with our stakeholders and partners in the highway industry. As the Infrastructure R&T Program moves forward, it will reflect an essential commitment to continuous improvement and, while further refinements and changes to the process are likely, our fundamental commitment to stakeholder involvement will not change. All future achievements of the program will be built upon this bedrock of stakeholder participation and partnership.**

# APPENDIX A

## Proposed Infrastructure Research and Technology Program

Federal Highway Administration

**Proposed**

# Infrastructure

# Research and Technology

# Program

Draft

Stakeholder Workshop
Chicago, Illinois
October 31 and November 1, 2002

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## PURPOSE

This white paper presents the Federal Highway Administration's (FHWA) preliminary thinking on the structure of its Infrastructure Research and Technology Program. The document should be viewed as a "straw man" that provides a point of departure for discussions at the October 31–November 1, 2002, ***FHWA Infrastructure Research and Technology Program Stakeholder Workshop***. FHWA is seeking input to refine the proposed program and make it more reflective of stakeholder requirements and related activities.

# INTRODUCTION

## The Backbone of the U.S. Transportation System

In the United States, highways are the personal transportation mode of choice, accommodating 90 percent of all travel by individuals each year. Our highways are also essential to trade and commerce, with more than 80 percent of the value of all U.S. freight moving over the Nation's highways.

The demands on our highway system have grown dramatically, with traffic volume increasing every year and trucks carrying more and more freight. Meanwhile, the system is aging. The average highway bridge is more than 40 years old. Pavements must be repaired or replaced every 10–20 years. We are faced with a gap: The rehabilitation needs of the system are growing and the resources available for highway agencies are inadequate to meet these needs.

## Breakthrough Technologies for Better Highways

The Federal Highway Administration (FHWA) recognizes the challenge of improving an aging highway system to meet increasing demands. In this challenge lies an opportunity to be seized by doing things differently. Many recently developed technologies and innovations are available to improve the safety, efficiency, reliability, and durability of our Nation's highways. Now is the time to put them into practice. Now is also the time to begin the long-term, high-risk, high-payoff research that will provide breakthrough technologies and decisionmaking practices to meet the transportation demands of the 21st century.

## The Infrastructure R&T Vision

FHWA is proposing a refocused and revitalized Infrastructure Research and Technology (R&T) Program to set a strategic direction for developing and deploying breakthrough technologies for highway infrastructure. The program represents a new way of doing business for FHWA, with an even greater emphasis on stakeholder involvement and partnerships. The entire highway community—Federal, State, and local agencies, national organizations, private industry, academia, and others—will have to work together to solve increasingly complex highway infrastructure issues.

## The Infrastructure R&T Approach

FHWA is committed to increasing stakeholder involvement in its Infrastructure R&T Program. The proposal presented in this paper is a single step in an ongoing and evolving process that will include the stakeholder workshop, a session at the 2003 Transportation Research Board (TRB) Annual Meeting, and continuing outreach efforts. The goal is to

create a structured, systematic process that will ensure strong stakeholder involvement in all phases of the Infrastructure R&T program.

## THE PROPOSED INFRASTRUCTURE R&T PROGRAM

### Elements of the Infrastructure R&T Program

The focus of the Infrastructure R&T Program marks a new way of doing business by recognizing and emphasizing the elements needed for success. The goals of the program are to enhance mobility and productivity, extend the life of pavements and bridges, and improve safety and performance. The path to achieving these goals requires the pursuit of four critical strategic elements:

- *Information*: reliable data for better decision making.
- *People*: training and professional development for an effective workforce.
- *Technology*: next-generation breakthroughs for better tools and techniques.
- *Deployment*: putting innovations into practice for achieving real-world benefits.

The following sections describe the purpose, scope, and strategies for each of the four elements. However, it is important to note that these four elements are not independent functions. They are interrelated and synergistic. A better-performing, more cost-effective, safer highway infrastructure cannot be attained without considering and investing in information, people, technology, and deployment as part of a strategic program.

### Information

Information about the condition and performance of the infrastructure system must be factual, accurate, and complete to support decisions regarding transportation investment and technology development and deployment. The focus of the information effort is to provide reliable data on how and why critical elements contribute to the performance of the highway infrastructure. The basic premise is that good information is critical to making good decisions.

FHWA's infrastructure information effort will include a number of strategies such as these:

- The Long-Term Pavement Performance (LTPP) program, which has been collecting information on the performance of 2,500 in-service pavement test sections distributed across North America since 1987.
- A new Long-Term Bridge Performance program.
- FHWA's mobile asphalt and concrete laboratories. The mobile labs serve a dual function as sources of information on construction materials and procedures and as tools for technology transfer.
- FHWA's test and evaluation program, which provides funding for the application and performance documentation of new innovative technologies.

Documentation from FHWA's technology deployment program. This documentation is a valuable source of information (refer to the description in the deployment

- strategies below).

**People**

The Infrastructure R&T Program will succeed only if the future workforce is up to the challenge. The objective of the people element is to provide and equip the managers, engineers, technicians, and workers for both the public and private sectors. "Provide" refers to expanding the workforce, while "equip" refers to education, training, information, tools, technology, guidelines, procedures, and best practices. Success in the people effort requires the partnership and cooperative efforts of State and local agencies, industry, academia, and FHWA. Within FHWA, this effort will be accomplished through a collaborative effort of the technical program offices, the Office of Professional Development, and the National Highway Institute (NHI).

The people component of the Infrastructure R&T Program focuses on new, advanced, state-of-the-art, and best-practice technologies. General training on basic skills and practices, while necessary, is not included as part of the Infrastructure R&T Program.

Strategies that will be utilized in the people effort are:

- Demonstration Projects to provide "hands-on" experience with innovative technologies and best practices (refer to the deployment strategies below).
- Technical assistance to aid the States and industry in the use of new technologies and in dealing with special projects and problems.
- Development of a suite of infrastructure training courses to be delivered by NHI.
- Support of university transportation centers (UTCs) to develop undergraduate and graduate infrastructure curricula that will include innovative technologies as part of the education of the next generation of engineers and managers.
- Establishment of a Web-based infrastructure knowledge system to capture and make available innovative technologies, information, and best practices.

**Technology**

Technology encompasses a broad spectrum of products and sources. Technology takes many forms, including analysis and evaluation procedures, cost and performance models, decision making procedures, design methodologies, test methods, equipment, guidelines, best practices, and materials. Sources of technology include FHWA, the National Cooperative Highway Research Program (NCHRP), the State departments of transportation (DOTs), industry, academia, and the international highway community.

The Future Strategic Highway Research Program (F-SHRP) will be an important source of technology. FHWA will pursue a complementary and coordinated track of research for topics being undertaken by F-SHRP. FHWA anticipates working with F-SHRP technologies in a similar manner as it did with the first Strategic Highway Research Program (SHRP). In the SHRP case, FHWA successfully led the test and evaluation,

refinement, promotion, education, training, and deployment of the SHRP technologies, such as Superpave®. With F-SHRP, FHWA envisions a collaborative effort in taking the F-SHRP technologies from research products to standard practices.

FHWA will focus on the research and development of high-risk, breakthrough, next-generation, and critical-gap technologies that meet a national need and have a large potential impact. FHWA's research and development will include:

- Advanced research that draws upon basic research results to provide a better understanding of problems and to develop innovative solutions.
- Applied research to provide practical and cost-effective solutions to problems.
- Development to transform these solutions into new technologies.

**Deployment**

Deployment will be the driving force for moving breakthrough technologies from concepts into practice and fully realizing their benefits. Accelerating the adoption and use of innovative technologies, information techniques, and management practices will require the cooperation, coordination, common vision, and combined efforts of the national highway community.

The objective in deployment is to support and promote the application of advanced technology and innovative thinking for infrastructure design, construction, operation, and management. Deployment takes place in the offices of the States and industry, on construction sites, and on the Nation's highways. It involves "hands-on" experience for the States and industry in the application of innovative technologies, procedures, and best practices. Within FHWA, deployment fully involves the division offices, resource centers, program offices, and research and development.

Strategies that will be utilized in the deployment effort are:

- A revitalized Demonstration Projects Program to package and deliver innovative technologies and best practices to the States and industry. FHWA's Demonstration Projects Program, which dates to the 1970s, is extremely well received and effective in the deployment of new technologies and procedures.
- Promotion efforts to inform States and industry and create an interest in applying the technology.
- Technical assistance to the States and industry to ensure that the technology is used correctly.
- Testing and evaluating promising new technology and innovative thinking. An associated benefit of testing and evaluation is the creation of technology champions for promotion, application, and technical assistance.
- Application of proven new technologies, innovative thinking, and best practices.

- Documentation of the performance, costs, and benefits of the testing and evaluation projects and the application projects. In the testing and evaluation stage, the documentation plays a critical role in the evaluation, identification of areas for improvement, and refinement of the technology.

**Proposed Resource Allocation**

As noted above, information, people, technology, and deployment are all critical elements in FHWA's vision for a better infrastructure. Based on the proposed program in three technical areas—asset management, structures, and pavements—FHWA is estimating the following levels of resource allocation for each of the four elements. We welcome feedback from our stakeholders regarding these estimates.

- Information—25 percent.
- People—10 percent.
- Technology—20 percent.
- Deployment—45 percent.

## STAKEHOLDER INVOLVEMENT

### Background

Although FHWA has a long and solid tradition of structured stakeholder collaboration in infrastructure R&T, we recognize that the transportation needs of the 21st century require an even greater commitment to a systematic process for stakeholder involvement. In the 1960s, the Federally Coordinated Research Program involved the States, industry, and academia in program development, conduct, and coordination of infrastructure research and development. In the mid-1980s, FHWA held a national workshop on pavement testing that heavily influenced the future direction of both SHRP's and FHWA's programs. In the 1990s, FHWA worked with the TRB to establish a TRB committee for SHRP implementation, ensuring stakeholder involvement in the deployment effort for SHRP products. In addition to the TRB-SHRP committee, FHWA established several management-level committees and numerous technical subcommittees to provide stakeholder input and assistance. Today, this tradition of stakeholder input and involvement is still functioning with such groups as the TRB-LTPP Committee, the TRB-Superpave Committee, and the TRB-Concrete Pavement Committee. The proposed Infrastructure R&T Program will further strengthen and systematize the process for stakeholder involvement.

Others have also recognized the need for greater stakeholder involvement. The development of the Infrastructure R&T Program has also been guided by recommendations from *The Federal Role in Highway Research and Technology*[1] (TRB Special Report 261) and *Highway Research: Systematic Selection and Evaluation Processes Needed for Research Program*[2] (General Accounting Office Report GAO-02-573).

TRB Special Report 261 examines the Federal role in the Nation's overall highway R&T effort, presenting recommendations on the focus of the Federal R&T program and the role of its stakeholders. Some of the key recommendations are:

*"FHWA's R&T program should:*

- *"…focus on fundamental, long-term research aimed at achieving breakthroughs."*
- *"…undertake research aimed at (a) significant highway research gaps not addressed in other highway R&T programs and (b) emerging issues with national implications."*

[1]Available online at http://www4.trb.org/trb/onlinepubs.nsf/web/trb_special_reports.

[2] Available online at http://www.gao.gov/new.items/d02573.pdf.

- *"…be more responsive to and influenced by the major stakeholders in highway innovation."*

The GAO report recommends that FHWA:

- *"develop a systematic approach for obtaining input from external stakeholders in determining the research and technology program's agendas;*

- *"develop a systematic process for evaluating significant ongoing and completed research that incorporates peer review or other best practices in use at Federal agencies that conduct research; and*

- *"develop specific plans for implementing these recommendations, including time frames and estimates of their cost."*

The Infrastructure R&T Program builds on the work of the National Highway R&T Partnership, cosponsored by the American Association of State Highway and Transportation Officials (AASHTO), TRB, and FHWA. The report issued by the National Highway R&T Partnership[3] identifies current needs for R&T to address national issues, and proposes new approaches to developing R&T programs. National R&T needs were identified in five areas: Safety; Infrastructure Renewal; Operations and Mobility; Policy Analysis, Planning, and Systems Monitoring; and Planning and Environment. For Infrastructure Renewal, the report identifies needs in six areas with a total annual cost of $243 million. The report also presents a conceptual description of how national R&T programs should function to make the best use of limited resources. A main consideration in this regard is to ensure sufficient coordination among stakeholders.

**Vision**

FHWA will ensure systematic stakeholder involvement in the structure, content, and conduct of the Infrastructure R&T Program.

**Approach**

The Stakeholder Workshop in Chicago, IL, on October 31 and November 1, 2002, is one step in a continuing process to involve stakeholders in developing, evaluating, and conducting the Infrastructure R&T Program. Specifically, FHWA desires stakeholders' assistance in the following areas:

[3] Information on the National Highway R&T Partnership, including its report, *Highway Research and Technology: The Need for Greater Investment*, is available online: http://www4.trb.org/trb/homepage.nsf/web/r&t_forum.

- Determining the focus and direction of the FHWA Infrastructure R&T Program.
- Identifying needs and gaps.
- Setting priorities.
- Thinking innovatively.
- Identifying opportunities.
- Identifying champions.
- Evaluating quality and value.

Characteristics or principles for stakeholder involvement are:

- Strategic rather than tactical.
- Long range rather than the immediate.
- Continuous and periodic rather than infrequent.
- Representative of a cross-section of the key stakeholders.
- Reliant on recognized leaders.
- Ensuring an equal voice for all participants.
- Maintaining objectivity.
- Providing insights: technical, operational, political, user, and others.

FHWA believes that multiple strategies for stakeholder input and involvement are needed, as in these current examples:

- Collaboration with AASHTO and the various committees such as the Standing Committee on Highways, Standing Committee on Research, Research Advisory Committee, Subcommittee on Materials Bridges and Structures, the Joint Task Force on Pavements, Task Force on Asset Management, and the Technology Implementation Group.
- Routine dialog with industry associations and groups.
- A broad-based infrastructure R&T communications program.

One possibility for structured stakeholder involvement in the future is the establishment of a TRB-Infrastructure R&T Committee. This committee would be similar in scope, purpose, and size to the current TRB LTTP or Superpave committee noted above. Please note that this is not intended as an all-inclusive list: FHWA is seeking fresh ideas and insights on the best way to build stakeholder involvement into the Infrastructure R&T Program.

The following sections provide an overview, at a strategic level, of the content of the three technical areas within the Infrastructure R&T Program: Transportation Asset Management, Structures, and Pavements.

# TRANSPORTATION ASSET MANAGEMENT

## Background

Transportation Asset Management (TAM) is a relatively new FHWA program, initiated in 1999. TAM provides a framework for the optimal allocation of resources by transportation agencies. When implemented, it will dramatically change the fundamentals of investment decisions. The breakthrough of TAM arises from the fact that the expenditure of funds will: (1) be based on tradeoff analysis where alternatives are considered across functions, asset classes, and even modes; (2) be driven by customer requirements as reflected in performance goals; (3) include economic as well as engineering considerations; (4) incorporate an extended time horizon; and (5) be systematic and fact based.

At its core, TAM will lead to the highest possible total return on investment, eventually reducing the gap between what the Nation needs to spend on its transportation assets and what it actually spends. Program success will reduce the total life-cycle costs of providing transportation services, and improve safety, system reliability and condition, and financial performance.

TAM works as follows: First, performance expectations, consistent with goals, available budgets, and organizational policies, are established and used to guide the decision making process. Second, inventory and performance information is collected and analyzed. This information provides input on current and future system requirements. Third, the use of analytical tools identifies potential strategies for allocating budgets to satisfy agency and user requirements. Alternative options are evaluated, consistent with long-range plans, policies, and goals. The entire process is reevaluated periodically through performance monitoring and systematic reviews.

A significant partnership has been formed to advance TAM. It includes the AASHTO TAM Task Force, NCHRP, FHWA's Office of Asset Management, the TRB TAM Task Force, and the UTCs, particularly those at Iowa State and Wisconsin.

Members of the partnership have worked individually and collaboratively to identify TAM research and technology requirements. The AASHTO TAM Task Force created a strategic plan and defined a research agenda. AASHTO, FHWA, and TRB collaborated to sponsor the National Highway R&T Partnership for Renewal of the Nation's Highway Infrastructure (R&T Partnership). TRB has produced a research "needs assessment" document. AASHTO, FHWA, and TRB have all taken steps to implement various aspects of their recommended programs. Other organizations, such as the American Public Works Association, the National Association of County Engineers, and the American Public Transportation Association, also have sponsored work related to TAM.

Progression toward comprehensive TAM is occurring on two tracks: The first focuses on the discrete components of TAM. The second track is concerned with implementing comprehensive TAM. Individual State and local transportation agencies have achieved significant progress in many of the component areas such as data integration, performance measurement, data-collection systems, and strategic planning. However, no agency has successfully implemented a comprehensive TAM program. The subject research and technology program addresses the components of TAM as well as comprehensive TAM.

It should be noted that work is underway throughout FHWA that, although not formally under the TAM umbrella, nonetheless addresses specific TAM components. For example, FHWA's Office of Program Administration has significant efforts underway in the area of innovative contracting. The Office of Asset Management, in addition to building and promoting the TAM decision making framework, also has work underway that involves the application of TAM concepts and principles to construction, maintenance, and system preservation initiatives.

**Vision**

The program vision is to create a new decision making paradigm that is holistic, based on fact, and driven by return on investment.

**Approach**

The proposed program's structure is simple: It brings awareness to the people who will influence the process leading to final investment decisions, and it teaches, trains, and educates the people who will implement TAM; it ensures the necessary data and information; it develops innovative analytical tools and techniques; and, finally, it provides assistance in actually deploying the tools, techniques, and processes. The program has been coordinated with and responds to many of the needs identified by the AASHTO Strategic Plan, the TRB scan of research gaps, and the R&T partnership.

The proposed program is not all inclusive; it does not address every research and technology area that has been identified as important to TAM advancement. It builds on the unique strengths of the FHWA and recognizes work underway and planned by other organizations. In addition, it focuses on the individual components, or building blocks, of TAM as well as on the comprehensive application. FHWA is committed to taking a leadership role in coordinating and integrating TAM research and technology activities within the transportation community.

**Information**

Information is central to the decision making process underlying TAM: to report on and monitor the condition and performance of the asset inventory base, develop performance objectives and measures, identify optimal investment strategies, and conduct asset value assessment. Information is also required for feedback to monitor the effectiveness of the TAM process. Data must be readily accessible, comparable, and credible.

Stand-alone management systems, such as for pavements and bridges, provide a rich foundation on which to build the data systems required for TAM. Bringing compatibility to the disparate data systems will be challenging, however, because each system is characterized by limited capabilities for data exchange. In addition, much work needs to be accomplished to enhance methods of capturing data and ensuring that data are of the highest quality.

FHWA has identified a research and technology program addressing the development of improved data-collection procedures, the interpretation of data, and data integration approaches. The proposed program calls for:

- Identifying innovative ways of using management systems as engineering tools to track the real-life performance of assets.
- Developing data collection standards and protocols.
- Producing inventories, evaluations, and reports on the alternative options and methods available for data collection and integration.
- Developing benefit-cost information and analysis techniques to support the evaluation of the cost-effectiveness of alternative approaches for making available the data required for TAM.

**People**

FHWA, with its partners, has waged a promotional campaign designed to establish a clear understanding of what TAM is, how it works, and what it is intended to accomplish. The goal is to achieve stakeholder buy-in to this new way of doing business. Stakeholders include agency executive leadership, legislatures, and the traveling public, as well as agency rank and file. The enormous change in an organization's business practices and the significant resource demands implied by TAM requires commitment from all relevant parties. FHWA proposes to continue work in this area.

A barrier to widespread adoption of TAM is the tremendous void in technical understanding. FHWA proposes to address this void through training in the nuts and bolts of TAM. Examples of topics that will be addressed include how to conduct a life-cycle cost analysis or basic training in areas such as economic analysis and accounting. Assisting agency staff in implementing new and existing technology is also urgent. We have developed an effective model for such training. For example, we have successfully provided training to assist users in implementing new technology, such as the Tunnel Management System, and existing technology, such as the Pontis Bridge Management System. Finally, agency staff must be trained in methods to interpret and translate the results of the analytical process into terms that are clear and relevant to a lay audience.

In addition to nuts-and-bolts training, organizational training is proposed as a priority. Comprehensive TAM impacts every function and level of an organization. TAM implementation requires that the different perspectives of all relevant parties be in alignment. In other words, there must be a shared vision, and information must be freely

communicated. Organizational training will concentrate on improving communication skills so that horizontal and vertical communication will be sufficient to support TAM.

Just as FHWA is making the case for TAM, so too must individual transportation agencies make the case to their constituents. Awareness training covers ways to ensure that decision makers will support TAM by developing their understanding of the principles and procedures of TAM and how its application makes sense from the perspective of economic efficiency. Organizations need assistance in reaching out to external groups and in promoting internal understanding.

Awareness and training activities include sponsoring, or cooperating in sponsoring, national TAM conferences, and workshops on specific subjects, peer exchanges, and Lead State seminars. A proposed high priority is the production and distribution of educational materials such as the Primer series, white papers, fact sheets, focused courses, and synthesis reports presenting the current state of the practice. We also plan to develop case study publications that share best practices and lessons learned. The case studies will cover issues ranging from technical applications to comprehensive TAM implementation. Key awareness and training delivery systems will include Web-based information exchanges, videos, CDs, and video-conferencing sessions. Products will be tailored to the target constituent groups.

Whereas awareness and training activities respond to immediate needs, education is viewed as an important long-term component of workforce development. TAM extends beyond traditional academic programs and encompasses many disciplines, including engineering, economics, finance, statistics, information processing, and management. The goal is to make TAM an option for formal study in colleges and universities across the country. FHWA proposes to participate in the development of academic centers for TAM where courses, work study, and degree programs would be offered.

**Technology**

The decision-support capabilities required for good practice of asset management require new and strengthened management systems and analytical tools. Management systems serve as key building blocks of the asset management framework. These systems are intended to cyclically monitor condition, measure real-life performance, predict future trends, and recommend candidate projects and preservation treatments. In addition, many of these systems include analytical tools such as deterioration models and optimization algorithms designed to evaluate the impacts and tradeoffs of current and future alternative policies, programs, and projects.

FHWA proposes to build on its long history of developing management systems, improving what is currently available, and pursuing the development of individual management systems where none exists or where the system is rudimentary. Specifically, work on bridge and tunnel management systems will continue and will be expanded to include improving the procedures used to estimate facility deterioration. New hardware and maintenance management systems, among others, will be developed.

The development of tools to facilitate the analysis of investment options in the context of developing optimal resource-allocation strategies will supplement and complement work focused on management systems. These tools are intended to rank other investment options according to relative economic merit, relate investment to facility and system condition and performance, and analyze risk. Through such analysis, information concerning the impact of choosing one investment alternative over another is provided to the asset-management process.

Specifically, FHWA proposes to continue its efforts to develop benefit-cost applications to include life-cycle analysis tools and the Highway Economic Requirements System–State Version (HERS-ST). In addition, FHWA plans to provide transportation agencies with greatly expanded documentation, recommendations, and technical assistance concerning engineering economic analysis (EEA) methodologies, probabilistic and sensitivity analysis, and optimization and prioritization routines.

Another particularly important focus area involves developing information to assist transportation agencies in estimating benefits. Benefits include reductions in accident costs, operating costs, negative environmental impacts, and travel times. These benefits are critical inputs to EEA methodologies. Much work has been accomplished in estimating the monetary value of such items as a human life, travel time, and emissions. However, specific values are difficult to infer and have received only limited consensus within the broad transportation community.

Finally, particular attention is directed at the presentation of results. It is important that reports be easily generated and interpreted; that data be summarized in a unified and meaningful fashion; and that results be organized and presented in a manner that contributes to further analysis and enhanced dialogue among decision makers. Outputs should be appropriate for communicating information to internal decision makers as well as those outside the transportation agency, and should support the effective articulation of the impact of choosing one alternative over another. An emphasis will be placed on packaging new technology with appropriate information display technologies.

**Deployment**

Although much work remains to be done, the technologies available (techniques, tools, processes) make possible immediate application of comprehensive asset management. The challenge is to bring the component approaches and technologies into wider use and pull the approaches and technologies together to create a comprehensive asset management decision making framework. Existing technologies and practices should be available so that eventually they may be adopted by a wide audience. The key to adoption is making managers both aware of the technologies and well informed about the benefits. The proposed deployment feature of FHWA's TAM research and technology program calls for making more people aware of the progress that others have achieved and the benefits that have been realized.

The deployment aspect of FHWA's research and technology program for TAM is critical. It recognizes that the risks and uncertainties associated with TAM implementation can be considerable. Demonstration of benefits, risk-sharing through financial and technical assistance, and the availability of fully tested products and approaches are ingredients vital to the success of any plan to move TAM to widespread adoption.

FHWA's program calls for a two-pronged approach: first, establishment of a State laboratory initiative where new tools and approaches can be pilot tested; second, a Lead State arrangement that provides opportunities for State volunteers to adopt specific components and strategies and then share their experiences and lessons learned with other agencies. It is anticipated that the Lead State program would support States in their initial efforts to adopt the TAM framework developed for AASHTO through NCHRP. This framework conveys TAM as a continuum, taking States through a long-term, step-by-step process of implementation, where elements are gradually phased into an organization's decision making process.

Examples of focus areas include

- Applying analytical tools such as HERS-ST.
- Developing and implementing performance measures.
- Adopting techniques for telling an agency's story to the organization's executive leadership.
- Addressing organizational, institutional, political, and legislative barriers to TAM implementation.

Evaluation will be conducted at regular intervals and corrections will be made as necessary. Follow-up efforts will be considered as appropriate. Documentation will be created to provide Lead State champions with material to support outreach activities.

A special feature of the deployment proposal is work to estimate the benefits of comprehensive TAM. Benefit estimates are useful in determining performance goals and communicating the value of asset management to a variety of constituents.

**Closing**

This section presents a proposed research, development, and technology delivery program to advance TAM. Stakeholder input regarding the technical aspects of this plan is requested. We are particularly interested in your assessment of its relationship to efforts underway or planned by other organizations in the TAM arena. Successful implementation of a coordinated, multiorganization TAM research, development, and technology delivery agenda will serve individual transportation agencies as well as the Nation by delivering systems with better condition, performance, and safety. We intend to solicit stakeholder input regularly as we proceed with implementation of the final plan. We welcome suggestions for improving the stakeholder input process.

# STRUCTURES

## Background

FHWA has reduced the number of substandard bridges from more than 250,000 in 1982 to fewer than 160,000 in 2001. Annually, the number of deficient bridges is being reduced by more than 5,000. Clearly, significant progress has been made; however, to achieve our strategic goals we need to decrease the number of deficient bridges by more than 7,000 per year. Our strategy is to build, replace, and rehabilitate at least 10,000 bridges annually over the next 5 years to exceed the bridge deterioration rate of about 3,000 newly deficient bridges per year. New bridges, however, are being designed and constructed with today's technology. Several facts point to a continuing problem with substandard bridges: traffic is projected to grow; most bridges built today will deteriorate at about the same rate as bridges built 20 years ago; most existing bridges are more than 40 years old. Additionally, this projected need for continuing renewal of the Nation's bridges will take place in an environment of unprecedented demands to not only keep traffic moving but to increase capacity and reduce delays to a minimum, and to keep costs, both initial and long-term, as low as possible. We must also not lose sight of the need to effectively and efficiently manage the existing bridge inventory. Even if we were to develop new technology today, it would take decades to reengineer the Nation's bridges. New challenges have also been presented in the area of homeland security.

This research program responds to needs identified in the National Infrastructure Renewal Research Agenda. The initiative for the bridge of the future specifically addresses the need for enhanced materials, structural systems, and technologies, as well as enhanced specifications for improved structural performance. The initiative for stewardship and management for the future specifically relates to the need for reliable and timely data and information, improved decision-support tools, and the development of quantitative, relevant, and useful measures of performance. The need to integrate probabilistic life-cycle analysis into infrastructure management is addressed in the third focus area, which assures the safety, reliability, and security of highway structures subject to extreme events.

## Vision

The program vision is to get out in front of the bridge deterioration curve *and stay there.* FHWA will work to develop and—in partnership with the States and industry—widely implement more durable bridges. The outcome of this program will be bridges that last longer, have far lower maintenance demands, and can be modified to accommodate changes in traffic or function much more quickly and far less intrusively than current technology allows.

## Approach

To effectively manage the existing inventory of bridges while we reengineer for the future, we must develop and deploy much more effective, powerful, and comprehensive decision-support systems. The bridge management systems of the future will be based on better information, better knowledge, better technology, and better decision-support tools. These systems will allow decision makers with the ability to select the optimal course of action for a bridge or population of bridges at any point in the life of the bridge and for any planning horizon. We also plan to develop and deliver new rehabilitation, strengthening, repair, maintenance, and preservation technologies to effectively and efficiently deal with our extensive as-built system. It is envisioned that replacement will become the option of last resort when deciding the optimal strategy for maintaining the Nation's highway bridges.

The research program described below will build upon the research conducted under the Transportation Equity Act for the 21st Century (TEA-21) and follow through with the development and delivery of totally new and innovative bridge systems that will help eliminate the bottlenecks of the future. This research program includes initiatives and programs addressing each of the four critical elements for success: people, information, technology, and deployment. Within this framework, FHWA's structures research program has three interrelated and concurrent themes or focus areas: developing and delivering the bridge of the future; management of our existing inventory of bridges as we reengineer for the future; and ensuring the safety, reliability, and security of the Nation's bridges. Our current thinking on what FHWA plans to do in each critical element is presented below.

## Information

FHWA's National Bridge Inventory and Inspection Program and the National Bridge Inventory database (NBI) provide the most comprehensive national-level source of long-term bridge information in the world. The FHWA has fully exploited the information in the NBI through its Bridge Management Information Systems Laboratory. FHWA is also completely knowledgeable about the element-level data currently being collected to support bridge management systems (such as Pontis) and is currently researching the utility of element-level data at the national level. Both the NBI and element-level data are based solely upon visual inspections, and information on hidden or invisible deterioration damage is not collected.

### *Long-Term Bridge Performance Program*

The nonquantitative, subjective, highly variable, and nonspecific nature of these data makes them inadequate for comprehensive life-cycle decision-support. A long-term bridge performance program is an essential element of research necessary to support the information needs for bridge management for the future. As noted, current bridge-inspection programs do not provide the detailed, quantitative performance information needed to predict long-term bridge performance reliably, thus a long-term bridge performance program, similar to the LTPP, is planned. A representative sample (in the

thousands of bridges) of in-service and new bridges will be selected. A program of detailed inspections and periodic evaluations will be conducted to monitor and measure the performance of these bridges over an extended period of time (at least 20 years and preferably longer). The resulting database will provide previously unavailable high-quality quantitative performance data for highway bridges to support improved designs, improved predictive models, and better bridge-management systems. A second component of this long-term bridge performance program would be a subset of instrumented bridges (in the hundreds) that would provide continuous long-term structural performance data. The third component would be the detailed forensic autopsies of several hundred bridges each year (out of the several thousand bridges demolished annually). We currently do not collect valuable performance data on corrosion, overloads, alkali-silicate reaction, or other essential deterioration processes from these decommissioned bridges.

### *Technology for improved bridge performance and condition data*

We also plan to address the more immediate, high-priority needs for rapid, nonintrusive, nondestructive, and quantitative condition assessments that tie directly to FHWA's strategic goals. A few of these assessment needs are rapid inspection of asphalt-covered bridge decks, rapid load testing and rating of bridges, inspection and safety assurance of bridge cables and tendons, and detection and assessment of cracks in structural steel. The FHWA plans to continue to emphasize the development of nondestructive evaluation technologies and methods to meet these needs as an integral part of our comprehensive strategy to improve the information available for informed decision making about optimal management of highway structures.

## People

FHWA plans to revitalize and modernize its use of demonstration projects as a key tactic for reaching out to our State DOT partners to introduce new technologies. Demonstration projects are a proven vehicle for introducing new technologies and methods to potential users, and we plan to use them in the structures area. We think it would be a useful to establish centers of excellence at a few universities. The centers would be the source for a next generation of academicians and researchers thoroughly familiar with the products of FHWA's research and development programs. It would probably be useful to tie this initiative to the UTC program created under TEA-21. We also plan to develop several new NHI courses in the structures area. NHI's current course catalog does not provide the comprehensive treatment necessary to fully serve the highway structural engineering community. Another key element of our plan to expand the workforce is to work more energetically and proactively with industry to help improve the knowledge, qualifications, and productivity of construction, fabrication, and manufacturing workers. We envision greater emphasis and support for industry certification programs as an example. FHWA is well aware that training can be expensive and time consuming. We also plan to fully explore and exploit new technologies, such as distance and computer-based learning, to help raise the level of technical knowledge and expertise across the industry.

## Technology

As has been the case traditionally, the major focus of our research and development program will be to develop new and improved technologies to meet the needs of the future. The bridge of the future is one vital initiative.

### *The bridge of the future*

The products of this initiative will be new generations of bridge systems that will provide unprecedented long-term performance. These systems will effectively use and combine high-performance materials into the most structurally efficient and cost-effective systems. The objective is to develop innovative bridge systems for new construction to meet the following performance objectives:

- Material degradation no longer a factor in limiting service life.
- One-tenth the current construction time.
- Bridges that can be easily widened or adapted to new demands in a few days.
- Life-cycle cost less than one-tenth of current bridges.
- Immune to flooding, earthquakes, fire, wind, fracture, corrosion, overloads, and vessel collision.
- Entire bridge (foundations to parapet) designed and constructed as a system.
- Lateral clearance greatly increased with longer spans.
- Elimination of vertical clearance problems with shallower structures.
- Constructability as important as durability.
- Designed for inspection and maintenance.
- Focus on new construction.

We recognize that these goals will seriously stretch our creative and technological capabilities. It is further recognized that we must also continue to effectively manage the existing multitrillion dollar investment in as-built infrastructure. This is the focus of our initiative in stewardship and management.

### *Stewardship and management for the future*

Stewardship involves more than the absence of waste or the presence of fiscal controls. It means having a business process that ensures that the best appropriate technologies and practices are used on every project and at every phase of a bridge's life cycle. The products of this research focus area will be comprehensive life-cycle decision-support systems and the technology to effectively and efficiently manage our tremendous in-service infrastructure. This involves much more than wrapping deterioration and having economic models in a software product. Comprehensive life-cycle decision support provides the knowledge, understanding, information, and technology to support good stewardship. Delivering this product would require little research if we already knew and

understood everything and had all the technology and information we needed. Unfortunately, the current state of knowledge and understanding of long-term bridge performance is inadequate for the comprehensive decision-support systems that are needed. There are several aspects to this initiative.

### *Knowledge, understanding, and technology for good stewardship*

The keys to good stewardship are knowledge and technology. FHWA plans to continue research to fill gaps in existing knowledge and technology. Examples of this type of research include continuing emphasis on fatigue and fracture mechanics and corrosion engineering and control. The recent failure of a bridge in Wisconsin and problems with tendon corrosion in Florida demonstrate that these needs continue. We are also proposing to newly emphasize research in strengthening, rapid repair, maintenance, and preservation. Continuing research and development of new nondestructive evaluation technologies will be a critical part of our stewardship initiative.

### *Comprehensive life-cycle decision-support systems*

Good stewardship requires good decisions. We plan to emphasize the research necessary to develop the underlying knowledge, understanding, and technology necessary to support comprehensive life-cycle decision-support systems. Some examples include the development of more realistic and accurate models to predict the long-term performance of bridges and bridge materials, the development and testing of new performance measures, and the research to measure and predict the effectiveness of typical maintenance and preservation actions. We also plan to continue to maintain world-class knowledge and capabilities in the application of information technologies to support this research.

Our stewardship and management initiative will address the long-term and routine factors limiting bridge performance, such as corrosion and fatigue. However, the most common cause of bridge failure is a catastrophic event, such as a flood or a collision. Also, new needs have been identified in relation to the threat of a terrorist attack. Dealing with rare and unusual events is the focus of our initiative to ensure the safety, reliability, and security of our Nation’s bridges.

### *Ensuring the safety, reliability, and security of the Nation’s bridges*

This part of FHWA’s Strategic Research Program will produce the knowledge and technology required to ensure that the Nation’s highway bridges are safe and that they will continue to function reliably in the event of an extreme or infrequent event. We propose a new research initiative aimed at developing the methods and technology to effectively and efficiently respond to threats to national security. The most plausible threats are blast, collision, and fire, and these will be included along with other identified threats within a logical and comprehensive modern risk-analysis framework.

FHWA also proposes to continue to conduct research to fill gaps in knowledge and to develop improved technology to ensure the safety and reliable performance of highway bridges exposed to other extreme and infrequent events. We will continue the hydraulics research program to work on the most frequent cause of bridge failure, scour. Wind-induced problems are still of significant concern and importance, as evidenced by recent problems with large-amplitude oscillation of cable stays under conditions of light rain and wind. Our aerodynamics research program will work to eliminate the problem on new bridges and develop workable countermeasures for existing bridges that exhibit the problem. The effect of a large earthquake on regional mobility has been experienced many times. It seems that each large earthquake teaches us new lessons, and new standards and new technologies often result. Our seismic research program has developed guidance for retrofitting existing bridges to make them less likely to fail during an earthquake. The seismic research program will develop new energy-dissipation technology to reduce the vulnerability of new bridges.

### *Emerging issues and technologies*

In addition to the research programs described above, there will be a continuing need for the FHWA to be prepared to respond to emerging issues and to exploit emerging technologies. It is essential for FHWA to be knowledgeable about and prepared to quickly advise policymakers and others on important technical issues. For example, FHWA must be informed and prepared to make important policy decisions on issues such as global warming. The implications of significant changes in weather patterns and variability are important and far-reaching. One credible scenario of global warming is a redistribution of water on a global scale, resulting in a lowering of the water level in the Great Lakes by several feet. The consequences to sedimentation processes and the consequent effect upon scour and stream stability at thousands of highway bridges is a matter of national significance. FHWA is also uniquely positioned to explore and exploit emerging technologies, such as Micro-Electro-Mechanical Systems, that have the potential to totally revolutionize construction process and quality control and to redefine what is possible for long-term measurement of structural performance and deterioration. Today the pace of technological change in the global transportation industry and the scale and scope of the challenges facing the Nation demand that FHWA assume this role.

So far we have outlined an ambitious and far-reaching program of outreach, research, and development to develop new knowledge and technology. All of this is needed and important, but the benefits of this work will not be fully realized unless and until this new knowledge and technology is put into practice. The final element for success is our plan to help deploy the results of our research and development programs.

## Deployment

We plan to build upon a decade of research in high-performance materials and to broaden and redirect the Innovative Bridge Research and Construction Program (IBRC) to be our primary mechanism for pushing new technology. The IBRC has been beneficial, but it is characterized by small incremental steps such as replacing steel reinforcement with polymers or replacing standard concrete with higher performing concrete. The motto of

the new IBRC program will be to *leave incrementalism behind.* The goal of the new IBRC is to demonstrate and spur the development of totally new and innovative bridge systems. We plan to broaden the scope of the IBRC beyond its current focus on new materials and new bridges to include new structural systems and strengthening, rehabilitation, repair, maintenance, and preservation technologies. We plan to more fully evaluate the performance of these new technologies and to share the experiences, both positive and negative, broadly. The emphasis of the new IBRC will be to deploy and evaluate those technologies that have the potential to become the new standards for the future. We are interested in developing and promoting technologies that have potential application on thousands of bridges, not a few.

**Closing**

**What we have described is our current thinking on a program of research, development, and technology delivery addressing many of the priority needs identified for highway structures. The program is strategic in nature but with specific long-range goals. We value and are asking for your review and feedback on the content of this program, and we are particularly interested in hearing how stakeholders should be involved as we move forward with this ambitious plan.**

## PAVEMENTS

**Background**

Pavements are the backbone of the U.S. transportation system, and essential to the Nation's economic well-being. Virtually all goods produced and sold in this country travel on the Nation's highways. From 1970 to 1998, the average daily highway traffic volume increased 130 percent, while average daily loading increased 580 percent. Average freight loading is currently increasing at 2.7 percent per year, and industry's reliance on just-in-time delivery has grown from 10 percent in 1990 to more than 60 percent in 2000. The commercial demand for both volume and load-carrying capacity in our highway system is accompanied by the public's demand for smoother roads with fewer delays and disruptions at a time when many of our pavements have surpassed their original design lives. In the next few years, more than 25,000 miles of the National Highway System will

require attention. Delivering pavement technology to address these needs is our critical challenge. The program proposed to deliver this technology is designated the Long-Life Pavement Program.

### Vision

The program vision is for long-life pavements that meet our customers' needs, are safe, cost-effective, and long-lasting, and can be effectively maintained. This vision will be realized through work focused on pavement-design systems, quality systems, user satisfaction, and workforce capability.

### Approach

As with all aspects of the proposed Infrastructure R&T Program, FHWA's proposed approach to achieving this long-life pavement vision will focus on: (1) information—providing the information needed to support sound decision making; (2) people—promoting and supporting development of a combined public- and private-sector workforce equipped with the knowledge and skills required to meet the challenges faced by the highway industry; (3) technology—generating advances in pavement engineering and construction technology through research and development; and (4) deployment—promoting and facilitating deployment of promising new highway pavement technology. Each of these elements of the approach is discussed below.

### Information

A group of activities is proposed to acquire information necessary to enhance pavement-related decisions and advance the technology used for long-life pavements. Data will continue to be collected for the LTPP database to complete the program. FHWA's mobile laboratories and pavement research laboratories would contribute materials characterization and performance test results to this information resource. Data gathered from full-scale accelerated testing by FHWA and other organizations would contribute information for our better understanding of materials behavior and performance in pavement sections. Field-testing and evaluation and demonstration projects would be used to evaluate developing technologies in full-scale pavements to understand them better. The resulting information would be the basis for refinements needed to ready the technologies for wide-scale use. On these projects, as well as on construction projects involving more finalized technologies, feedback from involved State DOTs and other partners would contribute information needed to perfect the technologies.

### People

A number of activities are proposed to develop a workforce for FHWA and our partners and stakeholders that will be able to deal with future challenges in the pavement industry. The first activity concerns updating college engineering curricula so that new engineering graduates will be equipped with knowledge of the current state of the practice, as well as state-of-the-art and developing technologies. This may involve one or more Centers of Excellence at selected universities, as well as the UTCs. Continuing education for practicing engineers and technicians would be supported through training courses and materials developed through coordination with a range of FHWA offices, including the NHI. This continuing education is intended to provide an online knowledge system to assist the workforce in learning about new technology. An interactive question-and-answer function as well as a searchable information database would be provided as part of this system. Learning by doing or learning by observation of experienced

workers often is the most efficient means of training. Participation by the workforce in test and evaluation and demonstration projects will contribute in this regard. To take full advantage of these activities, there must be adequate, advance communication and coordination so that the workforce knows what new technologies and learning opportunities are coming and can plan how to use those resources to best advantage.

**Technology**

FHWA proposes to pursue several approaches to advance the state of pavement technology. Research and development of new technologies would be directly achieved through a range of activities, including in-house staff research, contract studies managed by FHWA staff, interagency agreements with other agencies, cooperative agreements, and pooled-fund projects. The compilation and demonstration of best practices would also be carried out. FHWA proposes to also monitor external (to FHWA) research activities for pavement technology deserving further development or distribution. The State DOTs, NCHRP, and F-SHRP are among the likely sources for this technology.

Four areas of pavement technology advancement are proposed within the program. The results of these areas of concentration are termed *outcomes* and are:

- Advanced pavement design systems.
- Advanced quality systems.
- Enhanced user satisfaction.
- Enhanced capability of the technical workforce.

Our current thinking on the basis, approach, and individual objectives for each of these outcome areas is discussed in the following paragraphs.

***Advanced pavement design systems***

The process of pavement design continues to evolve and advance. With the completion of the AASHTO 2002 design guide, another milestone has been attained. However, even that milestone may not be the ultimate goal, although it is certainly a significant step along the way. We propose to pursue further improved design approaches, including steps toward a fully mechanistically based design procedure. This advanced pavement design systems outcome would encompass objectives that address structural design, materials selection/mixture design, and cost analysis.

Within structural design, the AASHTO 2002 pavement design guide would be targeted for widespread adoption by the end of the program. At the same time, it is envisioned that research would be conducted to enhance and extend the capabilities of the 2002 guide. Also, in anticipation of the next generation of the guide, additional information and models are proposed for development to provide a sound foundation for a truly mechanistic design process. Part of the informational input to this foundation would come from the completion of the LTPP program.

For materials selection and mixture design, the Superpave mix design system is proposed as an area of focus for continued enhancement and implementation. Also, materials characterization

methods are targeted for development to enable the more complete integration of materials selection/mixture design with structural design. In this area, a major project has just begun to develop guidelines for optimizing materials selection and mixture design for Portland cement concrete pavements. These improved tools for materials characterization and mixture design would be targeted for widespread use. They also would help achieve the objective of more scientifically based methods of pavement mixture design.

Cost analysis is often a key issue in pavement design, and the program would include pursuit of more widespread application of life-cycle cost analysis procedures to the design process.

### *Advanced quality systems*

The quality systems outcome area addresses the need to improve our ability to control the as-constructed quality of our pavements. At the end of the pavement design phase of a project, certain expectations have been established as to the quality and anticipated performance of the pavement to be built. This outcome area would develop the means to help ensure that these quality and performance expectations are met. It is proposed to divide the area into as-constructed quality, performance measures, and analysis systems to pursue reliable attainment of those expectations. The objectives within each of these topics are discussed below.

The objectives within the as-constructed quality area would be grouped in a sequence to advance from the current prescriptive or quality-control/quality-assurance specifications through performance-related specifications to performance-based specifications to warranties, with these objectives: (1) to further develop and implement performance-related specifications; (2) to develop the foundation for performance-based specifications; (3) to develop the application of warranties; and (4) to develop tools and techniques for the use of warranty contracts to optimize performance, cost, and risk.

To apply more advanced types of quality systems and specifications, better measurement and pavement characterization tools are needed. Accordingly, the proposed objective under performance measures is to develop the next generation of pavement evaluation tools.

To enable best application of quality systems and specifications, better systems will be needed to interpret and analyze the data collected. Therefore, under analysis systems, the first objective would be to optimize pavement quality standards. The second objective would be to further implement and continue to enhance the HIPERPAV™ (high-performance concrete pavements) software system for concrete pavements. Tools similar to HIPERPAV are also needed for asphalt pavements.

### *Enhanced user satisfaction*

Ultimately, user satisfaction with our highway systems is the overriding concern. If we design and construct pavements optimally, that satisfaction should be achieved. However, the user's satisfaction is tied not only to the end-result of that paving process (the pavements themselves), but also the process (particularly construction) and how that process affects highway system users.

Accordingly, three objectives are proposed to address the user's concern with congestion and

delay, surface texture and noise generation, and ride. For congestion mitigation, the objective would be to minimize traffic disruptions due to pavement construction, reconstruction, rehabilitation, and maintenance. This follows up on the theme of "Get in, Stay in, Get out, Stay out."[4] In the matter of ride, smooth pavements at construction and during the life of the pavement would continue to be a concern of FHWA. The proposed objective in this area is the widespread adoption of tools to assure smooth pavements. The texture of the pavement contributes to two areas of concern to the user—adequate tire/pavement friction for safety and noise generated at the tire/pavement interface. Often, acceptable levels in these two areas may be at odds with each other. Therefore, the objective in the texture area would be to optimize the surface characteristics of the pavement to achieve acceptable friction characteristics for safety while at the same time providing low pavement/tire noise levels.

### *Enhanced capability of the technical workforce*

The first two outcome areas of the proposed pavement program establish objectives to attain advanced pavement design systems and quality systems for construction. The third outcome area would build on the results of the first two outcomes, and use other results to enhance user satisfaction. To achieve these outcomes, even after the tools and techniques have been researched and developed, the technical capability of the workforce must be adequate to put the improved technologies into practice. Therefore, this fourth outcome on workforce technical capability is intended to help assure the understanding and proper use of the technologies developed, thereby advancing the state of the practice.

Three objectives are proposed for pursuit in this area, each contributing to increased knowledge and capability of the technical workforce involved in our paving projects. The first objective deals with formal education, and it would provide a broad spectrum of course materials for design, materials, and construction. In the continuing education area, an objective is proposed to develop a complete suite of training courses and materials. Finally, the objective of providing a system of accreditation for the requisite technician, testing, and inspection segment of the workforce would be pursued.

## Deployment

This last element of the program may be the most important, because without proper deployment of new pavement technology, state of the art never becomes state of the practice. The activities for pavements proposed herein are modeled after the current and proposed IBRC program. As such, the activities would focus on a push to develop, evaluate, and deploy new breakthrough technologies.

A number of activities would contribute to the successful deployment of these new technologies, including enhancement of the technical capability of the workforce (noted above). Another contributing activity is test and evaluation (T&E) projects, whereby the user gets to try, evaluate, and validate a technology on a trial basis on a project in the user's State. Documenting the results of the T&E projects would help the user better understand the technology, and at the same time

[4] *Get In—Get Out—Stay Out* (TRB Report No. ISBN O-309-07156-9). Available online at http://gulliver.trb.org/publications/sp/getin_getout_stayout.pdf.

help FHWA to incorporate any changes necessary to make the technology ready for more routine use. As the documentation from a series of T&E projects is compiled, data will also be accumulated to show the benefit of the application of the new technology. Demonstration projects and workshops focused on specific technologies would be used to familiarize State DOTs and industry with new technology. After a period of exposure and refinement through these activities, the technology would be ready for application in more routine paving construction, where FHWA would also be involved. Finally, the technology would pass into the category of state of the practice, where it would be a ready option for our partners and stakeholders in response to requests for project options and problem solutions. Technical assistance would be provided to our partners and customers throughout the entire deployment process.

## Closing

This section described proposed research, development, and deployment of a program to deliver long-life pavements, based on current and future needs. Successful conduct of the program is envisioned as providing pavements that are safe, better constructed, long lasting, cost-effective, and easily and effectively maintained.

Systematic and continuing stakeholder input and participation in the further development and conduct of the program is critical to its success.

## NEXT STEPS

We have presented our current thinking on the direction that FHWA's Infrastructure Research and Technology Program needs to move over the next decade or longer to help achieve the strategic goals of increased mobility, reduced congestion, and improved safety. Our proposed focus is on the longer-term, high-payoff research and development. We intend to develop and deploy breakthrough technologies that have the potential to change our expectations about pavement and bridge performance and change the way we manage our infrastructure systems. We have identified what we believe are the critical elements necessary to succeed: information, people, technology, and deployment.

We are proposing to fundamentally refocus and change our direction, and we are proposing to fundamentally change the way FHWA manages this research and technology program. The most significant aspect of this change is the role of stakeholders. It is our desire to involve stakeholders in every aspect of the process. The upcoming Stakeholder Workshop in Chicago is our first checkpoint to make sure we are going in the right direction. The feedback and input from this workshop will help us revise and sharpen our vision. We also hope the workshop will help better define how stakeholders should be involved as we move forward with this vision.

We will summarize the results of this workshop at a special session at the 82nd Annual Meeting of the Transportation Research Board. We anticipate that a refined vision statement will be developed by early spring 2003. We plan to build upon the recommendations from the Chicago workshop, input from the TRB Session, and continuing dialogue with our stakeholders and partners to design and implement a formalized process for continuing stakeholder involvement that we hope to put into place by fall 2003. An essential characteristic of FHWA's approach to management of the Infrastructure Research and Technology program is a commitment to continuous improvement. Further refinements and changes to the process are likely, but the fundamental commitment to stakeholder involvement will not change.

# APPENDIX B

## Infrastructure R&T Stakeholder Workshop PowerPoint Presentations

# FHWA Infrastructure Research & Technology Program
# Asset Management Group

Dave Ekern, Chair
Tim Lomax, Co-Chair
Theresa Fountain, Facilitator
Heather Tracy, Notetaker

# Vision

- **Why are we doing this?**
- **Is it new?**
- **Implement improved holistic asset management decision-making by developing the tools, data, training necessary to support implementation and improve customer service.**
  - **Move from FHWA Ownership to Partnership**
  - **Common goal: Greater reliance on stakeholder partners to accomplish the program.**

# Information

- **Integration** of disparate databases
  - Safety, Condition, Traffic, etc.
- Predictability Models
  - Condition, investment benefits, etc.
- Estimate Highway User Cost & Society Costs

(These 3 ideas equally ranked)

# People

- Provide Material for “trainers”, students and practitioners

  -LTAP

  -College/University Certificates
- Asset Mgmt. Institute to bring disciplines together

  -location-based

  -internet-based classes & certificate

  -both w/in college curriculum and outside
- Show how “silo” Mgmt. Systems relate to full Asset Mgmt Systems

# Technology

- Include tools to specifically link individual Mgmt. Systems to AM (include risk analysis)
- Interface AM w/ operations, safety, congestion, human resources
- AM is a process and analysis tools

  -need data integration process

  -institutional problems

  -complex & diverse issues in each state

# Deployment

- **Need deployment within FHWA (links needed to HQ and field offices**
- **Is Asset Mgmt the "program du jour"? How to give it "legs" – INSTITUTIONALIZE!!!**
  - **Demonstrate effective decisions from AM**
  - **Show that results are used**
  - **Enact in law**
  - **Create a Funding category**
- **Define perf. targets & not process**
- **Need more than just tools**

  **-Message to convey**

  **-Training required**

  **-Marketing strategy needed**

# Resource Allocation Results

- Technology 24%
- Information 26%
- Deployment 27%
- People 23%

- R&D – 50%, Deploym't – 50%

# FHWA Infrastructure R&T Stakeholder Workshop

## Structures Breakout Group

# Structures Breakout

- Global Issues
- People
- Deployment
- Bridge of the Future
- Stewardship
- Safety, Reliability and Security

# Global

- FHWA must take a leadership role in collecting and disseminating research in progress and research results from all sources (FHWA, SP&R, NCHRP, International)
- FHWA must keep its technical people current as technical experts and allowed to attend technical meetings (national and international presence)
- Redo the format of the Structures white paper
- Clarification of the time line for this proposal
- Stakeholder involvement excellent, future involvement needed to refine & prioritize

# People

- FHWA must continue and emphasize its role in training
- Assist states in providing models for managing R&D programs and sharing best practices

# Deployment

- Clarify that Delta-costs are included
- Concerned with leaving incrementalism behind
- Further stakeholder involvement in redefining IBRC is desired

# Bridge of the Future

- Objectives must be realistic
- Reorganize by shorter and longer term objectives
- Expand to include rehabilitation and methods
- Emphasize minimize impact on traveling public

# Stewardship

- Group felt the proposal has merit
- Real problem with format (long term bridge performance program)

# Safety, Reliability and Security

- Divide into natural and man-made (accidental & intentional)
- Methodology for quantifying safety and reliability is essentially a FHWA role

# FHWA Infrastructure R&T Stakeholder Workshop

## Pavements Breakout Group

# Framework

- Specific Outcomes Should be Defined
- Allocation of Effort Should
  - Vary by functional area
  - State ranges rather than numbers
  - Devote sufficient effort to research
  - Be better defined in terms of source
  - Not invite earmarking
- Transition Timeframe Needed

# Framework

- Role of FHWA
  - High-risk research
  - Leadership & coordination
  - Capturing & disseminating innovation by all
  - Identifying and filling gaps address
- Policy Barriers
  - Funding demo projects w/construction
  - Allow construction $ for innovation
  - Emphasize innovation throughout FHWA

# Framework

- Stakeholder Involvement Needs
  - Formal process
  - Program & project level input
  - Involvement of non-traditional stakeholders for fundamental research
- Vision Should Include “Environmental-Friendly”

# Needed Emphasis

- Pavement System Design, Not Just Mix Design
- Extend Use of Locally Available Materials
  - Less sensitive designs
  - Technology to allow use
- Performance Prediction Models
  - Pavement management
  - Tie performance to materials

# Needed Emphasis

- Traffic Prediction (Loading)
- LTPP
  - Assess process viability
  - Fill data gaps
  - Proactively analyze available results

# Needed Emphasis

- Training
  - Should address agency and contractor workforce as well as university
  - Pavement design training essential
  - Certification may be considered

# Needed Emphasis

- Pavement Management
  - Need broader concept than ROI
- Maintenance & Rehabilitation
  - Should be included
  - Is important to full asset management

# FHWA Infrastructure R&T Stakeholder Workshop

## Stakeholder Process Breakout Group

# Stakeholder – Introduction

- Briefed by FHWA on current Stakeholder Process
- Input from each Breakout Group
- Addressed the FHWA "White Paper"
- Identified recommendations for the Stakeholder Role on the FHWA Long-term R/T Program
- FHWA should continue to conduct AND coordinate research
- Security issues should be specifically included

# Stakeholder Group

- Endorse the “White Paper” with suggestions
  - Conduct and Coordinate
  - Discretionary Funds
  - Merit Reviews

# Stakeholder Group

- Three levels of Stakeholder Involvement
  - Strategic
  - Programmatic
  - Project

Stakeholder Group

# WHO?

# Stakeholder Group

- What
  - Formulate:

    Oversight, content (refinement), scanning

  2. Evaluate

     ongoing involvement, merit reviews, development -> acceptance

  3. Outreach

     networking, market the program, SHRP

# Stakeholder Group

4. Develop Resources

   $/time/people, general allocation

5. Address institutional issues

   procurement, matching & pooling funds, public/private partnerships

# Stakeholder Group

- HOW – Strategic
  - RTCC model
  - Steering Committee Model
  - Others?

# Stakeholder Group

- HOW – Project Level
  - Flexible
  - Merit Review
  - Innovative Technologies

# Stakeholder Group

- HOW – Programmatic
  - Advisory Function
  - Shared decision-making
  - Establish criteria for creating the program areas
  - Recognize interdisciplinary elements
  - Accommodate non-traditional areas
  - A need to define the context of highway infrastructure

# Stakeholder Group

- Technology
  - Human Resource Pool
    - Education
    - Training
  - Integration of Practice with Research
  - Dissemination of Findings

# Stakeholder Group

- In Summary –
  - Input from the stakeholder group
  - Input from the breakout groups
  - Input from ??????
  - There's more to do!!

# Appendix C

## Agenda for Infrastructure Research and Technology Stakeholder Workshop, Chicago, IL, October 31–November 1, 2002

# AGENDA

## Infrastructure Research and Technology Stakeholder Workshop
## Chicago, IL, October 31–November 1, 2002

October 31

| | |
|---|---|
| 10:00 a.m. – 10:05 a.m. | Welcoming Remarks<br>King W. Gee, Associate Administrator for Infrastructure<br>Federal Highway Administration |
| 10:05 a.m. – 11:15 a.m. | National R&T Perspectives<br>Moderator: Dennis Judycki, Associate Administrator for Research, Development, and Technology<br>Federal Highway Administration<br>J. Richard Capka, Deputy Administrator<br>American Association of State Highway and Transportation Officials<br>Dave Ekern, Associate Director of Engineering and Technical Services<br>Transportation Research Board<br>Robert E. Skinner, Jr., Executive Director<br>Transportation Research Board |
| 11:15 a.m. – 12:00 p.m. | FHWA Infrastructure R&T Program<br>Overview and Stakeholder Process<br>Byron Lord, Deputy Director<br>Office of Pavement Technology |
| 1:00 p.m. – 2:00 p.m. | FHWA Infrastructure R&T Program Proposals<br>Moderator: Charlie Churilla, Research Program Manager<br>Office of Infrastructure R&D<br>Asset Management<br>Regina McElroy, Evaluation & Economic Investment Team Leader, Office of Asset Management<br>Bridges<br>Steve Chase, Technical Director for Bridges<br>Office of Infrastructure R&D<br>Pavements<br>Steve Forster, Technical Director for Pavements |
| 2:00 p.m. – 2:15 p.m. | Charge to Breakout Groups<br>Charlie Churilla, Research Program Manager<br>Office of Infrastructure R&D |
| 2:30 p.m. – 5:00 p.m. | Breakout Groups |

**Infrastructure Research and Technology Stakeholder Workshop**
**Chicago, IL, October 31–November 1, 2002**

November 1

| | |
|---|---|
| 8:00 a.m. – 11:15 a.m. | Breakout Groups, continued |
| 11:15 a.m. – 12:00 p.m. | Preparation of Breakout Reports |
| 1:00 p.m. – 2:30 p.m. | Breakout Reports, Plenary Session<br>Moderator: Ian Friedland, Bridge Technology Engineer<br>Office of Bridge Technology<br>Breakout Session Reporters |
| 2:30 p.m. – 3:00 p.m. | Closing Remarks<br>King W. Gee, Associate Administrator for Infrastructure<br>Federal Highway Administration |

# Appendix D

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